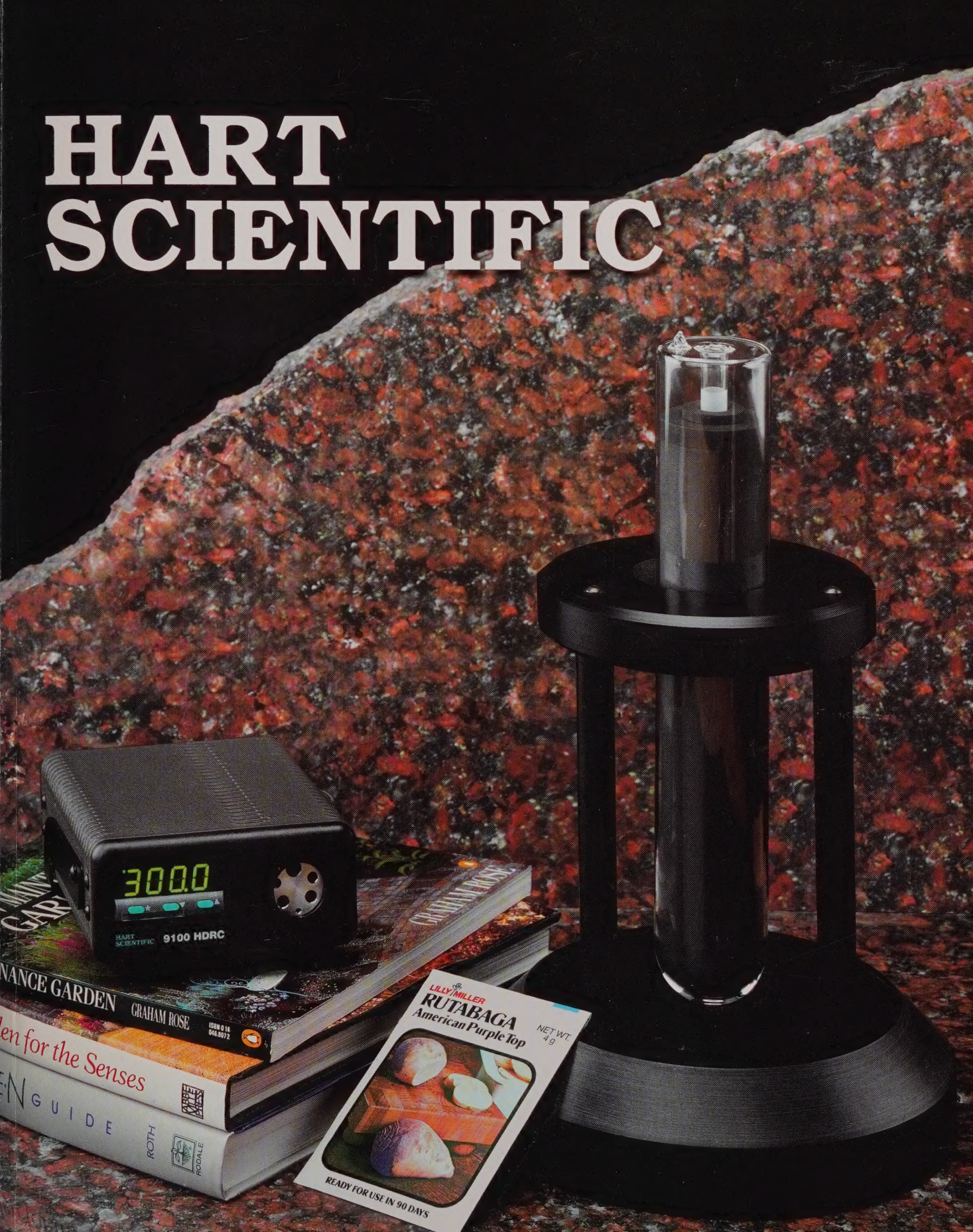
HART
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HART SCIENTIFIC 9100 HDRC
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READY FOR USE IN 90 DAYS

LETTER FROM THE CHAIRMAN

James C. Triplett
Chairman, CEO

Dear Hart Customer,

For the last couple of years this letter has described a lesson or two on customer service my father taught me while I worked in his hardware store. I've enjoyed writing those letters just like I enjoy writing many parts of this catalog.

During the seven years I've been with Hart Scientific many of you have stopped at trade shows or conferences to tell me how much you like the catalog, our products or our service. I really appreciate the things you've said. Every time any of us gives our best efforts to our work we hope someone else will notice and say something nice. Thank you very much for those compliments. They do more than simply make me feel good. They encourage our employees to keep giving their best for you. And your feedback helps us all improve. Every business is simply the sum of the people that work in it.

As you can see from this year's catalog, many things have changed. It's a color catalog now, full of new products, new people and new articles. It has some new pictures in it, too. They're not the pictures we planned because some of the employees were sure they would ruin their reputations along with the catalog by appearing in front of a camera. So we adapted. I hope you like the new catalog, the new products and those adaptations we've made.

Speaking of changes, there's one more change I haven't mentioned yet—and that's the change in Randy's job. He's now President and Chief Operating Officer of Hart. Randy is one of the most knowledgeable people I've ever met regarding metrology products. He knows calibration procedures, he understands customers and he has great vision about this business. With all these skills, obviously there's nothing left for me to do so we promoted him.

I'm not going on vacation or anything, it's just that we're getting much larger and we need broader management. Hart Scientific, as a whole, is approaching $10,000,000 in sales and 60 employees. We're continuing to introduce new products at a very rapid rate, we're building a bigger plant and we're expanding into new areas of temperature calibration.

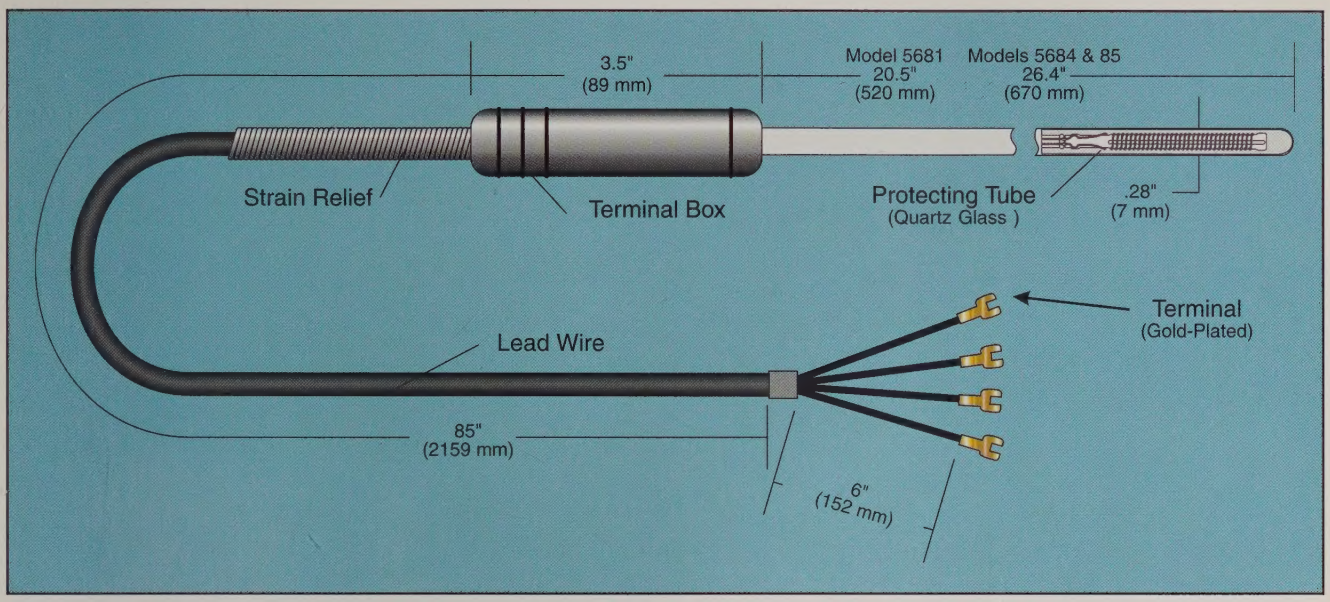
Randy, I'm sure, will continue to do the same excellent job he has done for the past seven years. The only doubt I have involves his singing. If he's going to help me with the Garth Brooks situation he has to be able to sing in certain customer service situations. (If you want an explanation of why he needs to sing, see our new "Never-Having-To-Say-We're-Sorry" program on page 146, and look for our new **H**andy **D**andy **R**andy **C**alibrator, too!)

To each and every customer, thank you very much for the opportunities you've given us to design and build products for your labs, develop new customer service programs and enjoy ourselves with you at trade shows and conferences.

The last seven years have been a most excellent adventure, and we're all looking forward to seven more years just as excellent.

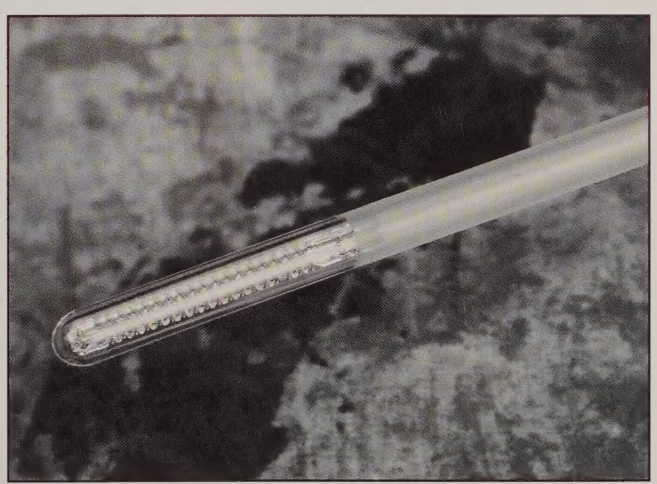
Sincerely,
Jim

Models 5681, 5684 and 5685



Specifications

Model	5681	5684	5685
Measuring Temperature Range	–189°C to 661°C	0°C to 1070°C	0°C to 1070°C
Resistance Value	25Ω	.25Ω	2.5Ω
Specified Current	1 mA	10 mA	2 mA or 3 mA
Resistance Ratio	W(302.9146K) ≥1.11807 and W(234.3156K) ≤0.844235	W(302.9146K) ≥1.11807 and W(1234.93K) ≥4.2844	
Sensitivity	0.1Ω/K	0.001Ω/°C	0.01Ω/°C
Drift Rate	<0.002°C/100 hours at 660°C (typically < 0.001°C)	<0.003°C /100 hours at 1070°C (typically <0.001°C)	
Protecting Tube	Quartz	Quartz	



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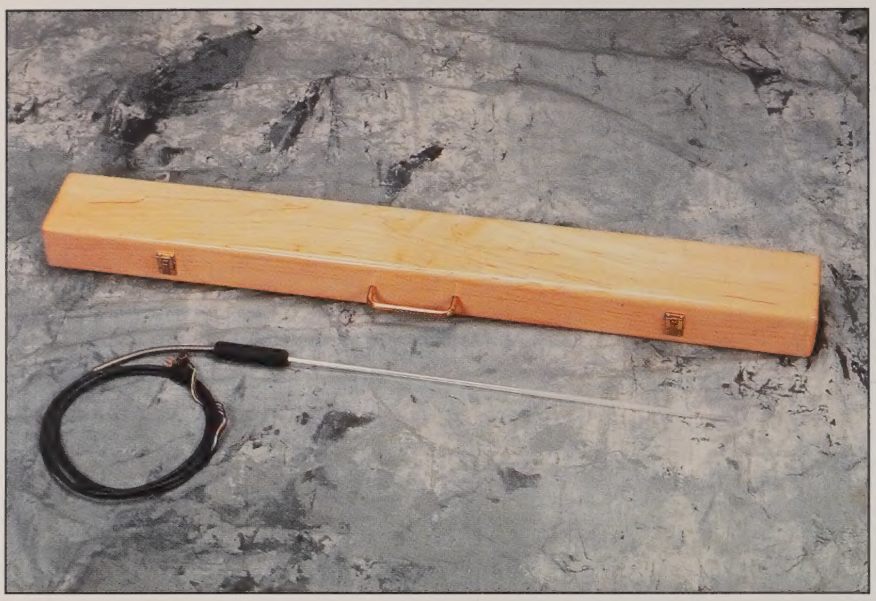
HART SPRTs



Hart SPRTs Model 5681/5684/5685
New designs manufactured in the U.S.
Meets all ITS-90 requirements
Drift rate typically less than 0.001K annually
Optional calibration choices

Hart manufactures three quartz-sheathed SPRTs to cover the ITS-90 range of –189°C to 961.78°C. The 5681 is our most popular SPRT and is used from –189°C to the Aluminum Point at 660.323°C. The Model 5684 and 5685 are both usable to 1070°C and can be calibrated at the Silver Point.

All three thermometers are carefully annealed at the appropriate temperatures and tested for stability. Convection prevention disks are used to reduce stem errors caused by thermal radiation or conduction. The quartz sheaths are pressure sealed with argon-oxygen atmosphere and fitted with a terminal box handle with a strain relieved connection to the four-wire cable. Gold-plated spade lugs terminate the wires. Each thermometer includes a foam lined maple carrying case.

Order your SPRT with or without calibration. You may send the thermometer to a lab of your choice or have Hart supply it complete with calibration and data. The Model 5681 is available with an economical comparison calibration or any one of several fixed-point calibrations matching ITS-90 subranges. We recommend the fixed-point calibration for the Model 5684 and 5685.

If you've never bought an SPRT before, these prices make it easier to buy your first. If you already have one, you can add a backup or extend your range to the Silver Point. One of our goals at Hart is to make the highest precision technology available to more of our customers. A milestone in that effort was the introduction of our new Model 1575 Super-Thermometer. Combine it with one of these excellent SPRTs and you'll have an easy-to-use system with the best accuracy available at a very affordable price.

5681: –189°C to 661°C

This 25 ohm thermometer is the workhorse of the ITS-90 ranges. It can be calibrated for any of the subranges from the Triple Point of Argon to the freezing point of Aluminum. The sensing element is crafted using high purity platinum wire wound in a strain free design on a quartz crossframe. The 5681 meets the ITS-90 requirements for resistance ratios as follows: $W(302.9146K) \geq 1.11807$ and $W(234.3156K) \leq 0.844235$.

5684 and 5685: 0°C to 1070°C

ITS-90 extended the use of the platinum thermometer from 630°C to 962°C. If you aren't using a high temperature platinum resistance thermometer (HTPRT) yet, it's probably because of its cost. Hart's 5684 and 5685 SPRTs meet this demanding application at a budget-fitting price. The 0.25Ω HTPRT sensor uses a strip shaped support made from high purity quartz. The 2.5Ω model uses the quartz crossframe. The platinum wire is wound bifilarly around the support. Stability after thermal cycling is excellent and the design is reasonably tolerant of vibration. Choose from 0.25Ω or 2.5Ω nominal R_0 values. In addition to meeting the resistance ratio requirements shown above, these thermometers meet the additional criteria: $W(1234.93K) \geq 4.2844$.

Ordering Information:

5681 SPRT 25 Ω, 661°C

5684 SPRT 0.25 Ω, 1070°C

5685 SPRT 2.5 Ω, 1070°C

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MODEL 9102 HDRC DRY-WELL CALIBRATOR — Range: –10°C to 122°C

Low-Temp Handheld Dry-Well	Model 9102
Fast cooling and heating rate	
World's smallest cold calibrator	
Two wells for comparison calibrations	

Hart Scientific recently introduced the world's first handheld dry-well calibrator, the Model 9100 HDRC with a temperature range of ambient to 300°C, and we're following it up with the Model 9102 HDRC handheld dry-well with a temperature range of –10°C to 122°C.

This new dry-well is only 3.25 inches high and 6 inches wide, achieves temperatures as low as –10°C, is NIST traceable and is accurate to ±0.5°C. This adds up to an unmatched package in dry-well size and performance, and it's available only from Hart Scientific.

The 9100 and 9102 dry-wells redefine portability and speed. You can take them anywhere you need to go and when you get there you won't have to read a magazine while you wait for them to reach their set point temperature.

With a temperature range of –10°C to 122°C, the Model 9102 HDRC is excellent for dial gauges, digital thermometers, bulb switches and other sensors that need calibration below ambient. It's perfect for ISO9000 quality programs because it's NIST traceable.

It has two wells so you can use one for a reference thermometer if you want even higher accuracy than the unit provides on its own. Both wells are ½ inch in diameter and each has inserts available for almost any size sensor.

Try this handheld dry-well and you'll know why Hart Scientific is the leading company in the temperature calibration industry.

Specifications

Range: –10°C to 122°C, 14°F to 251°F

Accuracy: ±0.5°C: –10°C to 100°C
±1.0°C: 100°C to 122°C

Resolution: 0.1°C

Stability: ±0.2°C, Typical

Cooling Time: 6 min., ambient to 0°C.

Heating Time: 10 min., ambient to 100°C

Stabilization: 5 min.

Wells: Two 0.5" wells x 4" deep with removable inserts sold separately. Includes 1/4" and 3/16" inserts.

Inserts: Available in 1/16", 1/8", 5/32", 3/16", 1/4", 5/16", 3/8", and 7/16" sizes

Depth: 4-inch immersion

Power: 90–264 VAC, 50/60 Hz; or 12 VDC 3A external input

Weight: 4 lbs.

Size: 3.25" H x 6" W x 6.75" D

Certificate: Includes 6-point NIST traceable certificate of calibration

Ordering Information

9102 Low-Temp Handheld Dry-Well
3102-0 Blank Insert
3102-1 1/16 Insert
3102-2 1/8 Insert
3102-8 5/32 Insert
3102-3 3/16 Insert
3102-4 1/4 Insert
3102-5 5/16 Insert
3102-6 3/8 Insert
3102-7 7/16 Insert

9308 Rugged Carrying Case

Specifications subject to change.

HART SCIENTIFIC
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1560 System Component Summary

Model 1560 Base Unit

Power: 100 to 240VAC, 50 or 60 Hz, nominal; Attachable Modules: up to 8; Display: 4.25" x 2.25" LCD graphics, LED backlight, adjustable contrast and brightness; Automatic input Sequencing: 1 to 99 channels; Communications: RS-232; Non-volatile Memory: channel sequence, probe coefficients

Extended Communication Module 3560

The Extended Communication Module gives added communication interface capability to the system. This module includes a GPIB (IEEE-488) interface, Centronics printer interface, and analog output. The GPIB interface connects the 1560 to a GPIB bus. GPIB can be used to control any function of the 1560 and read measurement data. The printer interface allows the 1560 to send measurement data to a printer. The analog output sources a DC signal corresponding to the value of a measurement.

Resistance Modules

Input Channels	Resistance Range	Resistance Accuracy	Resistance resolution	Temperature Range	Temperature Accuracy	Temperature Resolution	Excitation Current
SPRT Module 2560							
The Precision PRT Module will read 25Ω and 100Ω four-wire PRTs and SPRTs with very-high accuracy. Temperature can be displayed according to ITS-90, IPTS-68, Callendar-Van Dusen, or high-order polynomial characterizations. It can also measure and display resistance directly. The inputs are electrically isolated from the base and all other modules.							
2	0 to 400Ω	±20 ppm of reading (0.0005Ω @ 25Ω, 0.002Ω @ 100Ω)	0.001Ω	–260°C to 962°C	±0.005°C @ 0°C	0.001°C	1.0 mA, 1.4 mA
High-Temp PRT Module 2561							
The High-Temperature PRT Module will read 2.5Ω and 0.25Ω four-wire HTSPRTs and RTDs with very-high accuracy. Temperature can be displayed according to ITS-90, IPTS-68, Callendar-Van Dusen, or high-order polynomial characterizations. It can also measure and display resistance directly. The inputs are electrically isolated from the base and all other modules.							
2	0 to 20Ω	±200 ppm of reading (0.00005Ω @ 0.25Ω, 0.0005Ω @ 2.5Ω)	0.00001Ω	0 to 962°C	±0.05°C @ 0°C	0.01°C	3.0 mA, 5.0 mA
PRT Scanner 2562							
The PRT Scanner will read multiple two-, three-, or four-wire 100Ω PRTs. Temperature can be displayed according to ITS-90, IPTS-68, Callendar-Van Dusen, or high-order polynomial characterizations. It can also measure and display resistance directly. The inputs are electrically isolated from the base and all other modules.							
8	0 to 400Ω	±40 ppm of reading (0.004Ω @ 100Ω)	0.001Ω	–200°C to 850°C	±0.01°C @ 0°C	0.001°C	1.0 mA
Standards Thermistor Module 2563							
The Precision Thermistor Module will read thermistors with very-high accuracy. Temperature can be displayed according to Steinhart-Hart or high-order polynomial characterizations. It can also measure and display resistance directly. The inputs are electrically isolated from the base and all other modules.							
2	0 to 1 MΩ	±50 ppm of reading (0.5Ω @ 10 kΩ)	0.1Ω	–60°C to 260°C	±0.002°C @ 25°C	0.0001°C	0.01 mA
Thermistor Scanner 2564							
The Thermistor Scanner will read multiple thermistors. Temperature can be displayed according to Steinhart-Hart or high-order polynomial characterizations. It can also measure and display resistance directly. The inputs are electrically isolated from the base and all other modules.							
8	0 to 1 MΩ	±200 ppm of reading (2Ω @ 10 kΩ)	1Ω	–60°C to 260°C	±0.005°C @ 25°C	0.001°C	0.01 mA

Thermocouple Modules

Input Channels	Millivolt Range	Millivolt Accuracy	Millivolt Resolution	Temperature Accuracy, Ext. CJC	Temperature Accuracy, Int. CJC	Temperature Resolution	
Precision Thermocouple Module 2565							
The Precision Thermocouple Module will read thermocouples with high-accuracy. It can read any of the standard types including K, J, T, S, R, B, E, N as well as gold-platinum. Temperature can be displayed using the standard characterizations or calibrated characterizations. It can also measure and display millivolts directly. It includes an internal cold junction compensation reference but external CJC can be used as well for better accuracy. The inputs are electrically isolated from the base and all other modules.							
2	0 to 100 mV	±0.002 mV @ 50 mV	0.0001 mV	±0.05°C	±0.1°C	0.01°C	
Thermocouple Scanner 2566							
The Thermocouple Scanner will read multiple thermocouples. It can read any of the standard types including K, J, T, S, R, B, E, and N. Temperature can be displayed using the standard characterizations or calibrated characterizations. It can also measure and display millivolts directly. It includes an internal cold junction compensation reference but external CJC can be used as well for better accuracy. The inputs are electrically isolated from the base and all other modules.							
12	0 to 100 mV	±0.004 mV @ 50 mV	0.001 mV	±0.1°C	±0.3°C	0.01°C	

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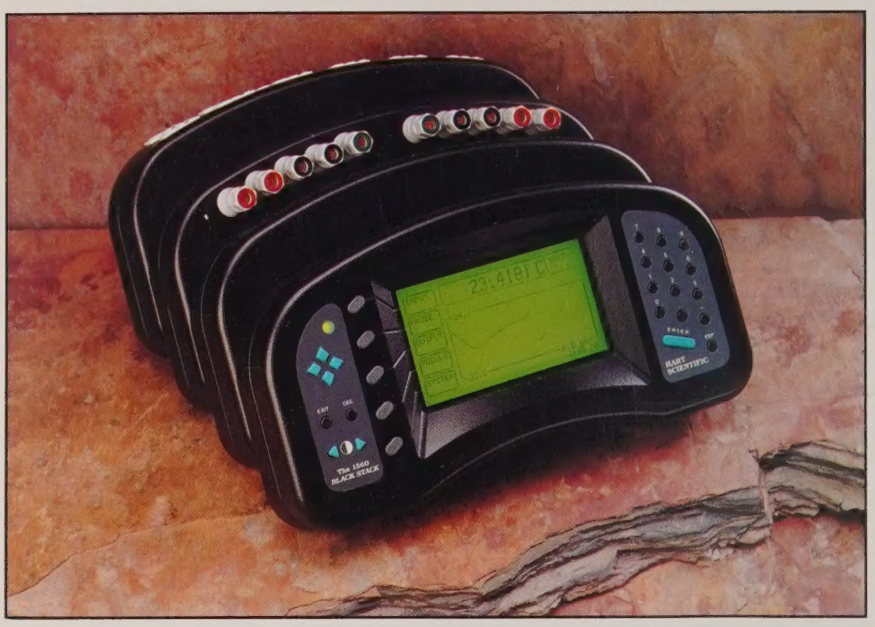
HART MODEL 1560—THE BLACK STACK



If you need a thermometer that's flexible and changes to meet your needs, we've got one for you.

It reads PRTs, SPRTs, thermocouples, thermistors and more. It supports up to 99 channels and completely replaces a thermometer and DMM combination. It's innovative, easy to use, fast, programmable and re-configurable when your needs change.

If you want a moderately priced reference thermometer to read a calibrated PRT, you simply buy the basic unit and the 2 channel PRT module. The LCD screen will guide you through the thermometer's functions and provide you with all the data you need to an accuracy of 0.005°C with a resolution of 0.001°C.

Over time, of course, your needs are going to change. But what if you've already invested in *The Black Stack?* You've spent your money and your time learning to use it; should you just start over with a completely new instrument? You would have to if you had bought a thermometer from someone else, but the engineers at Hart designed *The Black Stack* to change when your needs change. It's as easy as plugging in a new module. You won't have to take anything apart, change any chips or jumpers or even reprogram your unit. When you plug in your new module, the 1560 automatically reads it, configures itself and changes its LCD information display to the new thermometer you've just created.

Each module is calibrated individually and stores its own parameters and calibration information independently, but all the data is readable from the 1560's display. The unit features a proprietary digital bus which links the units together and requires no calibration of the base unit itself.

Start with a 2-channel PRT/SPRT basic unit for a reference thermometer, and then add more modules to read more reference probes or to read the sensors you're calibrating. If you'd like, stack in the 12-channel thermocouple unit that reads any type of TC and provides its own cold junction compensation, or add an 8-channel PRT module or a thermistor module. Create exactly the type of thermometer you need without having to learn a new instrument, write software or buy multiple pieces of unrelated equipment to get your job done.

The IEEE or RS-232 port connects *The Black Stack* to your computer for complete automation of your calibration work. Why buy a DMM, a scanner and a reference thermometer when one *Stack* does it all? (Compare Figure 1 and Figure 2.)

The competition has to sell you multiple instruments because they don't know how to build one like *The Black Stack.*

Call us for more information. You'll be surprised to learn that you can own *The Black Stack* for less than $3,500.

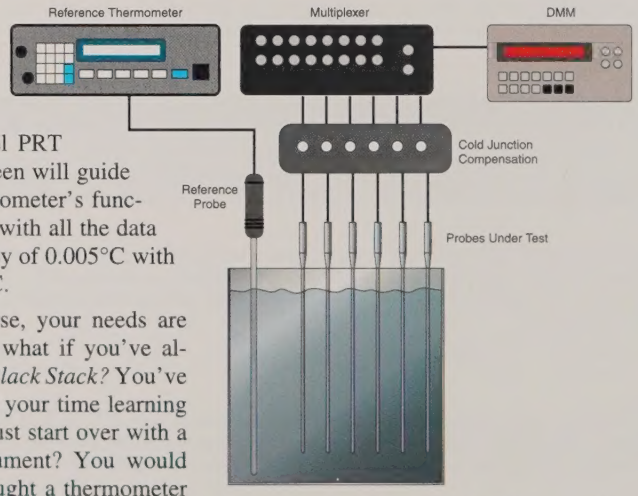


Figure 1. The traditional method for calibrating multiple sensors.

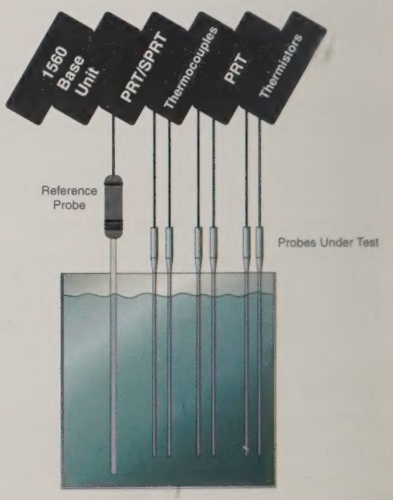


Figure 2. One instrument does it all. Stack it the way you need it.

PRELIMINARY DATA SHEET. SPECIFICATIONS SUBJECT TO CHANGE.

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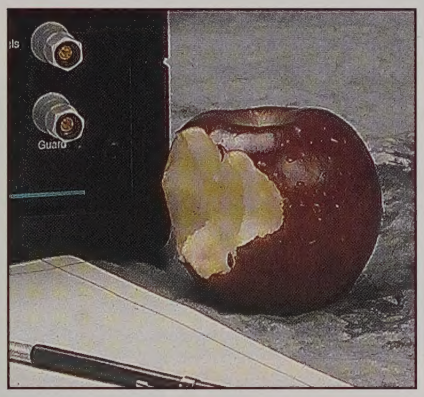
"Never-Having-to-Say-We're-Sorry"

See Page 146.

We've got a new customer service program. If we don't meet our commitments to you, we're going to give you something much better than a simple apology. Check out how this one works with our "Service-or-We-Pay" program.

Where Is the Apple?



See Page 146.

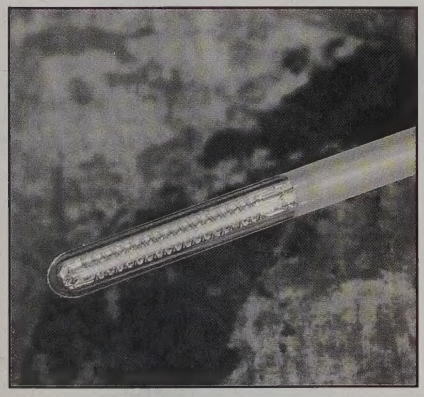
Did you notice there's no apple on the cover? The apple was very popular. We had orders for several last year. Read our new top ten list of why the apple isn't on this cover, and enjoy the catalog.

9100 HDRC Handheld Dry-well

See Page 100.

Our new Model 9100 breaks traditional portability standards with the industry's first and only handheld dry-well. Now you can test thermocouples, RTDs, bi-metals and other thermometers with a handheld dry-well, rather than on a bench in the lab. Each unit comes with a NIST traceable certificate of calibration.

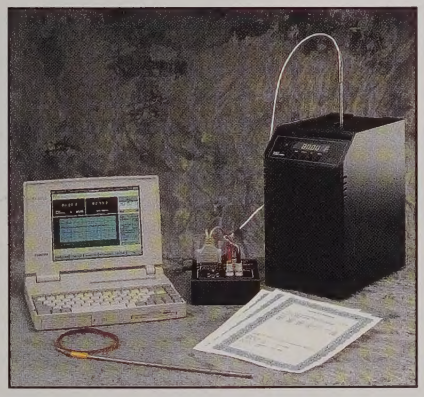
Hart SPRTs



See Page 10.

We make these high quality resistance thermometers in our own factory in Utah. You'll see and feel the craftsmanship of each assembly. Our design complies with ITS-90 guidelines, and if you take advantage of the introductory pricing and you give one of our SPRTs a try, you'll discover their measurement stability to be among the best in the industry.

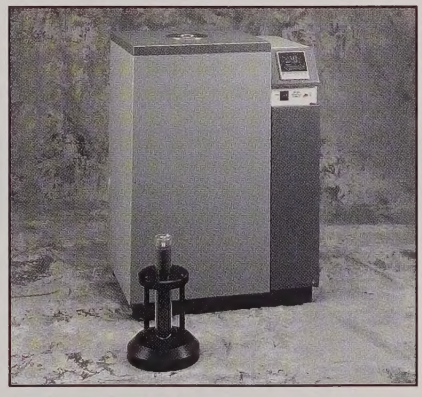
Easy Automated Calibration



See Page 112.

Calibration or testing of industrial RTDs and thermocouples consumes a lot of time. This Windows™ software package runs on your PC along with Hart's 9105, 9123 and 9122 dry-wells to do most of the work for you. The computer runs the test and prints the report while you work on something else. See a complete descripton on page 112 for all of the features

High Temp Freeze Point Furnaces



See Page 26 and 28.

This year we have two new furnace designs. The Model 9115 Sodium Heat Pipe Furnace has a range of 500°C to 1000°C and gradients less than 0.1°C. It replaces obsolete furnaces in your lab for the maintenance of Aluminum and Silver Point Cells. Our other new furnace, the Model 9116, gives you graduated heater windings in a single zone design for use up to 1100°C. Use the 9116 with Copper and Gold Point Cells.

A NOTE FROM RANDY—A NEW PAGE AND A NEW JOB!

Dear Hart Customer,

This is a new page in the catalog and it comes with my new job.

I've been with Hart for about seven and a half years. Every year, when it's time to do a new catalog, I think about our first attempt at doing one with all of the problems and friction it caused. But somehow we got it done, and this year it's in color and bigger than ever before. It's filled with new articles, new products and of course, a few new jokes. And it's the jokes that bring me back to my new job.

I'm President and Chief Operating Officer of Hart now, and I'm pleased to be in that position even though what I actually do won't be changing much from what I've been doing during my first seven years. What I do—what we do—at Hart really is a team effort, and I think it's one of the most talented teams in the temperature calibration industry. Well, almost everything is done in teams except the jokes. Jim still does those himself, and no matter what he said in his letter, he is the only one who sings to people on the phone.

Randy, Xumo and Mike have a surprise! Is this a new product under the cloth or Randy's prizewinning rutabaga?

In addition to the little bits of humor in the catalog, you'll also find a variety of products, some of which you won't find anywhere else. These products are the result of our thinking about the way you work and what you need to do your job as productively and cost effectively as possible. We try to limit our opinions, engineering urges and theoretical ramblings as much as we can to bring you accuracy with ease of use.

One of our most popular new products is the Model 1575 Super-Thermometer. It offers the best price-to-accuracy ratio in the industry along with a powerful set of built-in metrology features for saving time and money.

Remember the bridge trade-in program? We got many more offers than we could accept, and the trades included many of the industry's biggest names and highest accuracy instruments. The Super-Thermometer measures to 4 parts per million and saves hundreds of dollars and many hours of labor on every calibration. Because of the success of the trade-in program, this year we're going to have an antique instrument sale.

While you're looking around the catalog be sure to read about the new Hart Model 9100 HDRC Handheld Dry-Well Calibrator. It's the only handheld calibrator in the industry. It reaches 300°C without toasting your fingers. You said you wanted a dry-well calibrator less than the size of luggage so we built you one, and now you can take it anywhere you go.

Hart's the only company that designs and builds this broad of a range of temperature calibration instruments. We have the metrology technology, the mechanical engineering, the electrical engineering and the customer knowledge to bring you the best instruments in the field. We try as hard as we can to do exactly that every time. And, of course, there's more new stuff on the way. We've got one of the most provocative instruments you'll see this year or next, but we're not going to show it to you just yet.

Building temperature calibration products is our business, our only business, not our hobby. Gardening is our hobby, so if you want information on prizewinning rutabagas call us at home (1-900-GET-RUTA). If you want to talk about temperature calibration call us at the office (1-800-GET-HART). Call us and we'll listen.

Randy

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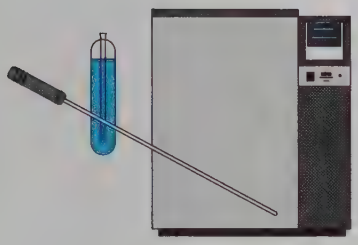
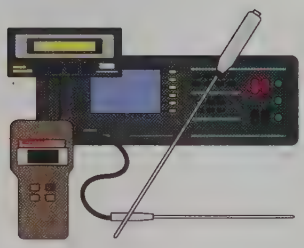


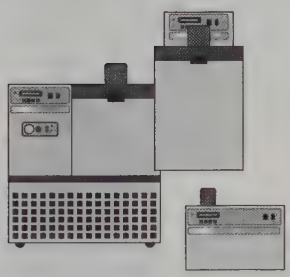
Primary Standards Page 6

- Standards Platinum Resistance Thermometers
- Fixed-Point Cells
- Furnaces and Apparatus



Thermometry Page 30

- Standards Thermometer Readouts
- Reference Probes
- Industrial Reference Thermometers

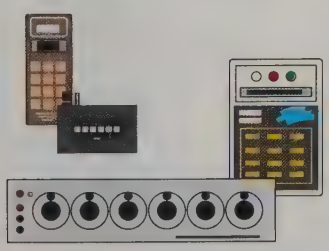


Baths Page 58

- Refrigerated Baths
- Standard Heated Baths
- Benchtop Baths
- Standard Resistor Baths

Dry-Wells Page 96

- Handheld Dry-Wells
- Industrial Dry-Wells
- High Accuracy Dry-wells
- Furnaces



The Best of the Rest Page 120

- RTD and Thermocouple Simulators
- Digital Multimeters
- Humidity Monitors and Calibrators
- Software
- Carrying Cases

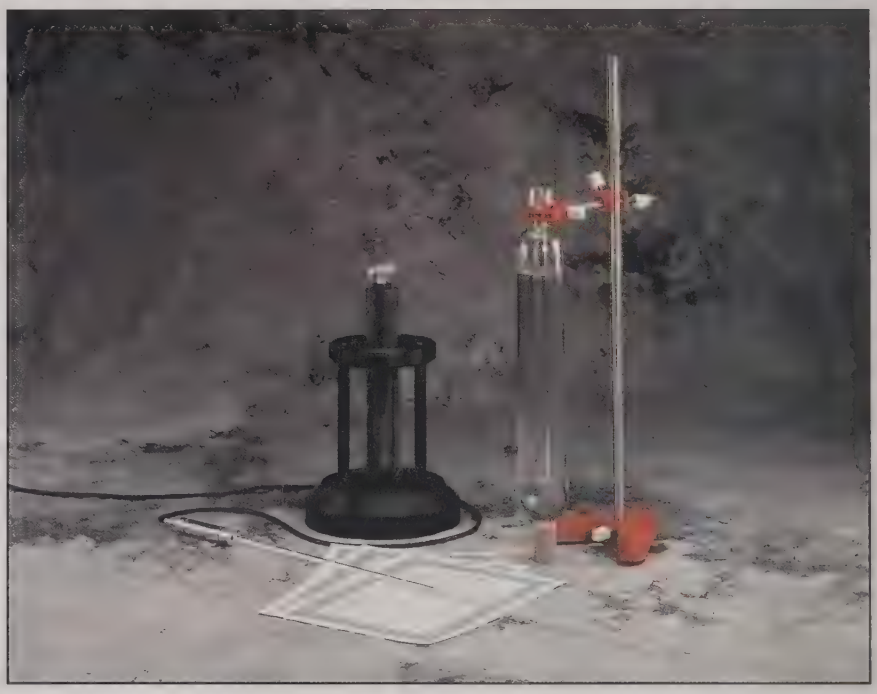
INTRODUCTION TO PRIMARY STANDARDS

Hart's collection of primary standards is the best and broadest available from any temperature calibration company. This year we've added new fixed-points, furnaces and SPRTs with more to come.

Hart's line of fixed-points offers the lowest expanded uncertainties available commercially. Certain natural phenomena, such as the melting or freezing of high purity metals, are very reproducible and are used as absolute reference points in the calibration of thermometers. Hart cells are used to produce the ITS-90 fixed-points under laboratory conditions.

Furnaces and baths are used to initiate the melting or freezing of fixed-points and then maintain the cells at the fixed-point temperature. Hart designs its apparatus for ease in setting up a fixed-point and for maximum duration of the fixed-point equilibrium. Look at the features and specifications—you won't find anything better on the market.

SPRTs are used as interpolation standards. They are calibrated at the fixed-points and then are used as standards for temperatures in between the fixed-points and in the comparison calibration of lesser or "working" standards. No one offers a better selection than Hart. We're proud to bring you the best in the world, including Hart's own new designs manufactured in Utah.



If you're considering primary standards, don't take chances and don't settle for less. Call Hart and we'll discuss your plans, and help you in any we can.

SPRTs

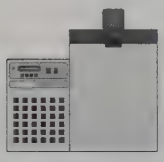
	Manufacturer	Model	R_{tp}	Range	Price	Page
	Hart	5681	25Ω	–189°C to 661°C	$2,895	10
		5684	0.25Ω	0°C to 1070°C	4,250	
		5685	2.5Ω	0°C to 1070°C	3,890	
	Rosemount	5687 162CE	25.5Ω	–200°C to 661°C	3,528	12
		5688 162D	25.5Ω	–260°C to 250°C	2,925	14
		5689 162K	0.25Ω	0°C to 1100°C	5,096	15
	Chino	5602	25.5Ω	–189°C to 962°C†	6,600	16
		5603	2.5Ω	–189°C to 1065°C†	8,000	
		5604	0.25Ω	–189°C to 1065°C†	8,600	
	YSI	5675 8163-Q	25.5Ω	–200°C to 650°C	3,800	18
		5676 8167-25	25.5Ω	–200°C to 650°C	4,780	
	Netsushin	5660	3Ω	0°C to 1000°C	5,490	9
		5661	5Ω	0°C to 1000°C	$5,490	

†Hart metrologists DO NOT recommend the calibration and use of a SPRT over the complete range from –200 C to temperatures above the Aluminum Point (661°C). An HTPRT is normally calibrated from the TPW (0.01°C) to the Silver Point (about 962°C).

Fixed-Point Cells

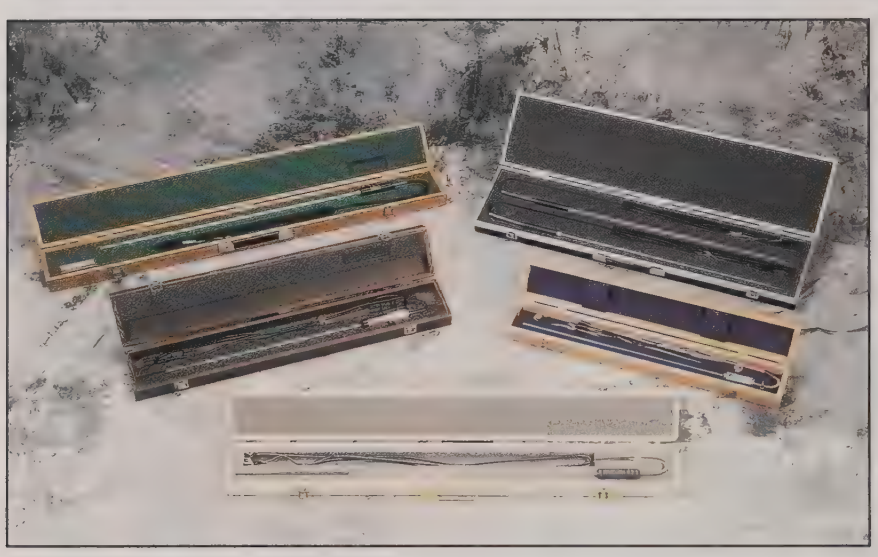
	Model - Description	Temperature	Price	Page
	5901 Triple Point of Water	0.01°C	$950	20
	5903 Gallium Melting Point	29.7646°C	6,590	21
	5904 Freeze Point of Indium	156.5985°C	12,500	23
	5905 Freeze Point of Tin	231.928°C	8,800	
	5906 Freeze Point of Zinc	419.527°C	7,800	
	5907 Freeze Point of Aluminum	660.323°C	8,900	
	5908 Freeze Point of Silver	961.78°C	13,900	
	5909 Freeze Point of Copper	1084.62°C	$9,700	

Apparatus

	Model	Features/Use	Price	Page
	7012 TPW Maintenance Bath	Maintains: Triple Point of Water and Gallium Melting Point Cells. Comparisons: –10°C to 110°C	$7,900	66
	7037 Triple Point of Mercury Bath	Maintains: Mercury Triple Point, Triple Point of Water and Gallium Melting Point Cells. Comparisons: –40°C to 110°C	9,950	67
	9114 Metrology Furnace	Maintains: Indium, Tin, Zinc and Aluminum Freeze Point Cells. Comparisons: 100°C to 680°C	17,500	24
	9115 Sodium Heat Pipe Furnace	Maintains: Aluminum and Silver Freeze Point Cells. Comparisons: 550°C to 1000°C	19,800	26
	9116 Single Zone Furnace	Maintains: Aluminum, Silver, Gold, and Copper Freeze Point Cells; Comparisons: 500°C to 1100°C	$19,600	28

Temperature Scale

STANDARD PLATINUM RESISTANCE THERMOMETERS



Hart Scientific sells a variety of SPRTs, including the ones we design and manufacture right here in Utah. All of these SPRTs have one thing in common, they're the best in the world and we sell them because we want to match your needs and preferences for different thermometers.

As you read about each instrument, it is apparent they have many things in common, as well as differences in how they look, feel and approach certain design issues. There is no one SPRT that is right for every calibration or customer need.

We use many of the SPRTs we sell in our own calibration lab, and we offer SPRT calibration services. We can answer your application questions and help you select the instrument that's right for your specific use.

Once you've decided what's right for your lab, we can help with the calibration and maintenance of your standard. Several options are available:

1. The manufacturer of the SPRT can calibrate it.
2. Hart can calibrate it for you before shipment.
3. We can send it to your favorite third party laboratory.
4. We can send it to NIST. You can make arrangements directly with Greg Strouse at NIST (call us for his number) and we'll ship it for you (reducing handling and risk) or we'll do the paperwork ourselves and send it to you, complete with its NIST certificate.

For calibration pricing see the table below.

This group of SPRTs includes thermometers manufactured by Rosemount Instruments, Chino Corporation, Yellow Springs Instruments, and the new Netsushin High Temp SPRT designed in conjunction with NRLM and the Japanese National Lab. The Hart SPRTs feature new designs from Xumo Li manufactured by Hart in Utah.

Read about them, talk with us and be assured your high precision, high performance instrument will perform the way you thought it would.

Call us at **1-800-438-4278** (1-800-GET-HART).

Calibration Options

Comparison Calibrations

Order No.	Range	Price	Order No.	Range	Price
1803	–100°C to 450°C	$595	1804	–100°C to 661°C	$750

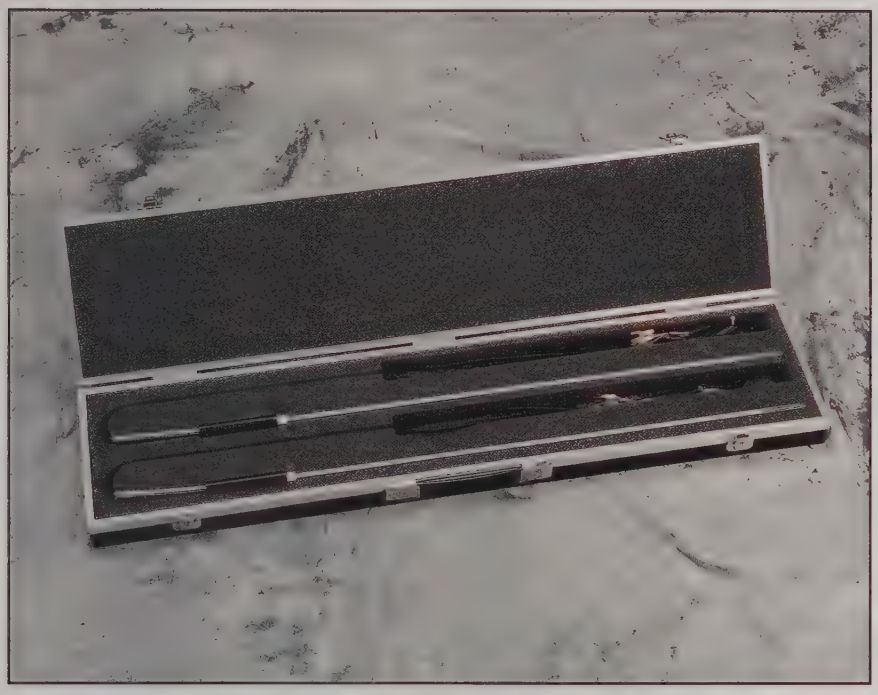
Points:	–100°C	–38°C	0.01°C	232°C	420°C	661°C
Uncertainty:	0.011°C	0.005°C	0.003°C	0.008°C	0.013°C	0.021°C

SPRT is calibrated by comparison to a NIST calibrated SPRT in liquid baths (comparison furnace at 661°C). Resistance measured by DC ratiometric technique using Hart Model 1575. Calibration certificate supplied with ITS-90 constants and W_r vs. T table.

Fixed-Point Calibrations

Order No.	Range	Price	**Expanded Uncertainty** (coverage factor K=2)
1811	0°C to 157°C TPW to In	$600	Triple Point of Water (0.01°C) = 0.2mK
1812	0°C to 232°C TPW to Sn	1,200	Freezing Point of Indium (156.5985°C) = 0.8mK
1813	0°C to 420°C TPW to Zn	1,200	Freezing Point of Tin (231.928°C) = 1.0mK
1814	0°C to 661°C TPW to Al	2,000	Freezing Point of Zinc (419.527°C) = 1.2mk
1815	0°C to 962°C TPW to Ag	3,200	Freezing Point of Aluminum (660.323°C) = 4.0mK
			Freezing Point of Silver (961.78°C) = 20mK

SPRT is calibrated using ITS-90 fixed-points. Certificate includes ITS-90 constants and W_r vs. T tables.
Calibration points below 0°C are currently taken using comparison methods. Call us for price and future availability of low-temp fixed-points.



Netsushin HTPRT	Models 5660 and 5661
New high temperature PRT design	
3Ω and 5Ω models	
Range is 0°C to 1000°C	

Netsushin Corporation is known for its high quality wire-wound PRTs. Their high temperature reference thermometers shown here are constructed using their new patented technology. Scientists from NRLM and the Tokyo Metropolitan Institute of Technology participated in the development and evaluation of the design. Recently they asked Xumo Li to test some samples in Hart's metrology lab. We added it to the catalog to give you one more choice in HTPRTs.

The design of the sensing element itself is quite unique. The resistance values of 3 and 5 ohms are higher than other HTPRTs on the market today. A special ceramic material is used in the sensor support structure and in the insulation and support of the platinum wires through the length of the stem. The sheath is high quality quartz and is delustered to minimize heat piping effects. The flexible lead cable is insulated with silicone and is terminated with gold-plated spade lugs.

Each of these thermometers comes in a protective carrying case. You can order the HTPRT with or without calibration. See page 8 for information on calibrations from Hart's lab.

Ordering Information:

5660 HTPRT, 3Ω 1000°C	**$5,490**
5661 HTPRT, 5Ω 1000°C	**5,490**

Hart's 1575 Super-Thermometer is the most cost effective readout for low resistance HTPRTs. See page 36.

Specifications

Model	5660	5661
Resistance	3Ω ±0.5Ω	5Ω ±0.5Ω
Temperature Specific Characteristic	$R_{100}/R_0 \geq 1.39260$	$R_{100}/R_0 \geq 1.39260$
Operating Temperature	0°C–1000°C	0°C–1000°C
Self Heating (Water Triple Point)	1mA=0.3mK, 3mA=3mK	1mA=0.3mK, 3mA=3mK
Sensitivity	0.01Ω/K	0.02Ω/K
Repeatability	±10mK (±0.01°C)	±10mK (±0.01°C)
Protecting Tube (Material/Dia./Length)	Quartz-Al_2O_3/5mm/600mm	Quartz/5mm/600mm

HART SPRTs QUARTZ SERIES

Hart SPRTs Quartz Series	Model 5681/5684/5685
New designs manufactured in the U.S.	
Meets all ITS-90 requirements	
Drift rate typically less than 0.001K annually	
Optional calibration choices	

Hart manufactures three quartz-sheathed SPRTs to cover the ITS-90 range of –189°C to 961.78°C. The 5681 is our most popular SPRT and is used from –189°C to the Aluminum Point at 660.323°C. The Model 5684 and 5685 are both usable to 1070°C and can be calibrated at the Silver Point.

All three thermometers are carefully annealed at the appropriate temperatures and tested for stability. Convection prevention disks are used to reduce stem errors caused by thermal radiation or conduction. The quartz sheaths are pressure sealed with argon-oxygen atmosphere and fitted with a terminal box handle with a strain relieved connection to the four-wire cable. Gold-plated spade lugs terminate the wires. Each thermometer includes a foam lined maple carrying case.

Order your SPRT with or without calibration. You may send the thermometer to a lab of your choice or have Hart supply it complete with calibration and data. The Model 5681 is available with an economical comparison calibration or any one of several fixed-point calibrations matching ITS-90 subranges. We recommend the fixed-point calibration for the Model 5684 and 5685.

If you've never bought an SPRT before, these prices make it easier to buy your first. If you already have one, you can add a backup or extend your range to the Silver Point. One of our goals at Hart is to make the highest precision technology available to more of our customers. A milestone in that effort was the introduction of our new Super-Thermometer on page 36. Combine it with one of these excellent SPRTs and you'll have an easy-to-use system with the best accuracy available at a very affordable price.

5681: –189°C to 661°C

This 25 ohm thermometer is the workhorse of the ITS-90 ranges. It can be calibrated for any of the subranges from the Triple Point of Argon to the freezing point of Aluminum. The sensing element is crafted using high purity platinum wire wound in a strain free design on a quartz crossframe. The 5681 meets the ITS-90 requirements for resistance ratios as follows: $W(302.9146K) \geq 1.11807$ and $W(234.3156K) \leq 0.844235$.

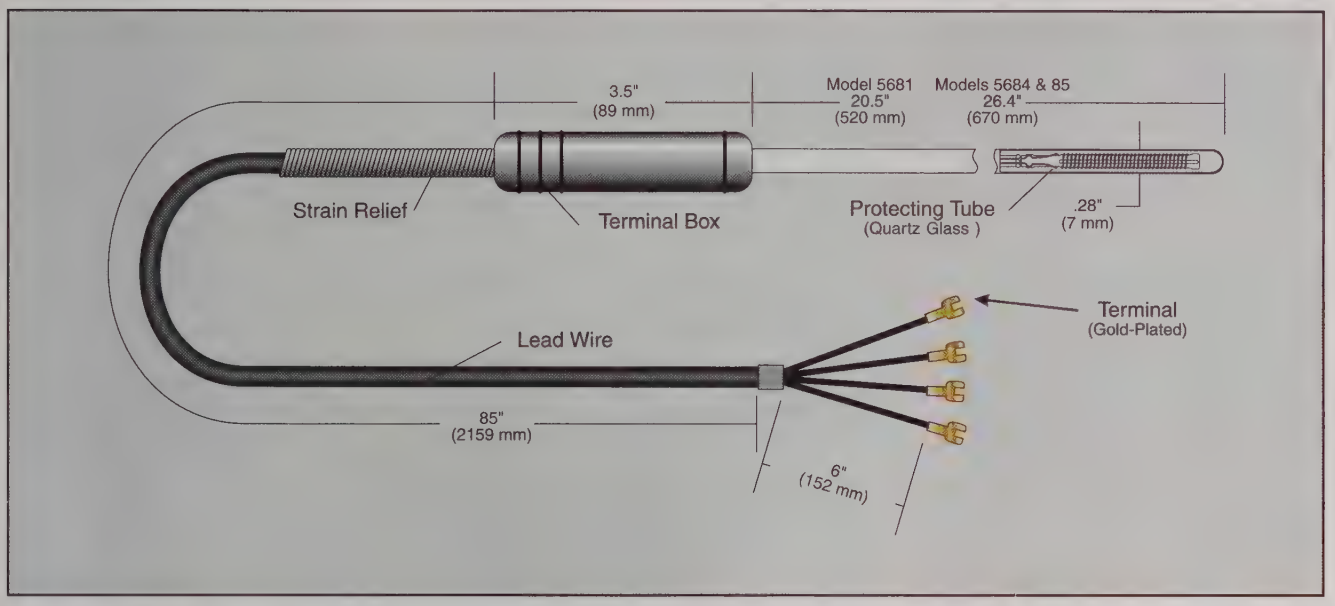
5684 and 5685: 0°C to 1070°C

ITS-90 extended the use of the platinum thermometer from 630°C to 962°C. If you aren't using a high temperature platinum resistance thermometer (HTPRT) yet, it's probably because of its cost. Hart's 5684 and 5685 SPRTs meet this demanding application at a budget-fitting price. The 0.25Ω HTPRT sensor uses a strip shaped support made from high purity quartz. The 2.5Ω model uses the quartz crossframe. The platinum wire is wound bifilarly around the support. Stability after thermal cycling is excellent and the design is reasonably tolerant of vibration. Choose from 0.25Ω or 2.5Ω nominal R_0 values. In addition to meeting the resistance ratio requirements shown above, these thermometers meet the additional criteria: $W(1234.93K) \geq 4.2844$.

Ordering Information:

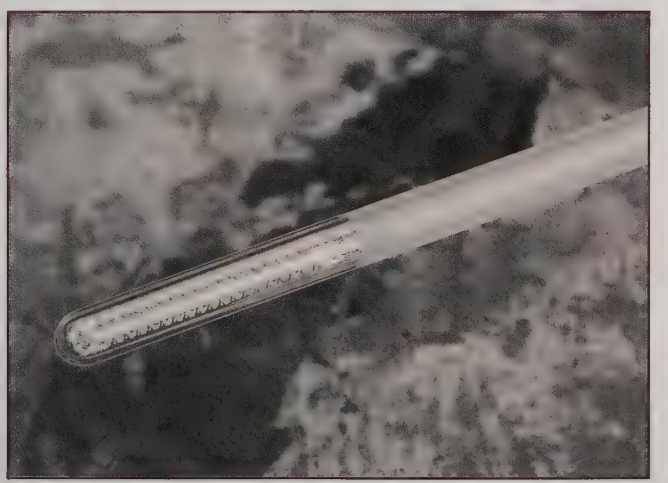
5681 SPRT 25 Ω, 661°C	**$2,895**
5684 SPRT 0.25 Ω, 1070°C	**4,250**
5685 SPRT 2.5 Ω, 1070°C	**3,890**

Hey, check these prices!



Specifications

Model	5681	5684	5685
Measuring Temperature Range	–189°C to 661°C	0°C to 1070°C	0°C to 1070°C
Resistance Value	25Ω	.25Ω	2.5Ω
Specified Current	1 mA	10 mA	2 mA or 3 mA
Resistance Ratio	W(302.9146K) ≥1.11807 and W(234.3156K) ≤0.844235	W(302.9146K) ≥1.11807 and W(1234.93K) ≥4.2844	
Sensitivity	0.1Ω/K	0.001Ω/°C	0.01Ω/°C
Drift Rate	<0.002°C/100 hours at 660°C (typically < 0.001°C)	<0.003°C /100 hours at 1070°C (typically <0.001°C)	
Protecting Tube	Quartz	Quartz	



Rosemount®	Model 162CE
Metal sheath	
Range –200°C to 661°C	
Stability better than ±0.010°C per year	
Capable of Aluminum Point (660.323°C) calibration	

Hart and Rosemount are two of the best known names in temperature calibration, and this year we've teamed up to offer three Rosemount SPRTs direct to you from Hart along with several Rosemount-Hart calibration instrument combinations featuring the best system accuracy available.

The Model 162CE SPRT shown on these two pages is one of the most popular and versatile of the Rosemount line. It is a metal sheathed thermometer with a range of –200°C to 661°C which takes it to the Aluminum Point of 660.323°C. It has a stability of better than ±0.010°C per year.

The platinum resistor is made from fully annealed, high-purity platinum wire and is mounted essentially strain free. The temperature standard combines ruggedness with accuracy and has many desirable operational features, such as very low self-heating, a metal sheath, insensitivity to pressure and a hermetically sealed platinum resistor.

Construction

All four leadwires of the thermometer connecting the element to the housing assembly are platinum, insulated by a ceramic tube. The element is hermetically sealed in a metal sheath containing a helium-oxygen atmosphere.

The metal sheath and housing provide a rugged instrument that can be used in a wide variety of fluid media. A compression fitting and mating part are provided for use in pressure vessels up to 2000 psia.

A silicone rubber jacketed cable, eight feet long, contains the four external copper leadwires. A stainless steel coil spring provides strain relief into the housing. Each leadwire terminates in a heavy gold-plated spade lug.

Stability

The temperature standards have a stability of better than ±0.01°C (per year) over the specified temperature range. Typical stability is ±0.001°C (per year) over a nominal 100°C range.

Self-Heating

The temperature rise (self-heating) of the platinum resistor elements above the temperature of the case is less than 0.002°C at a current of 2 mA. The nominal value is 0.0003°C with a 1 mA current.

Insulation Resistance

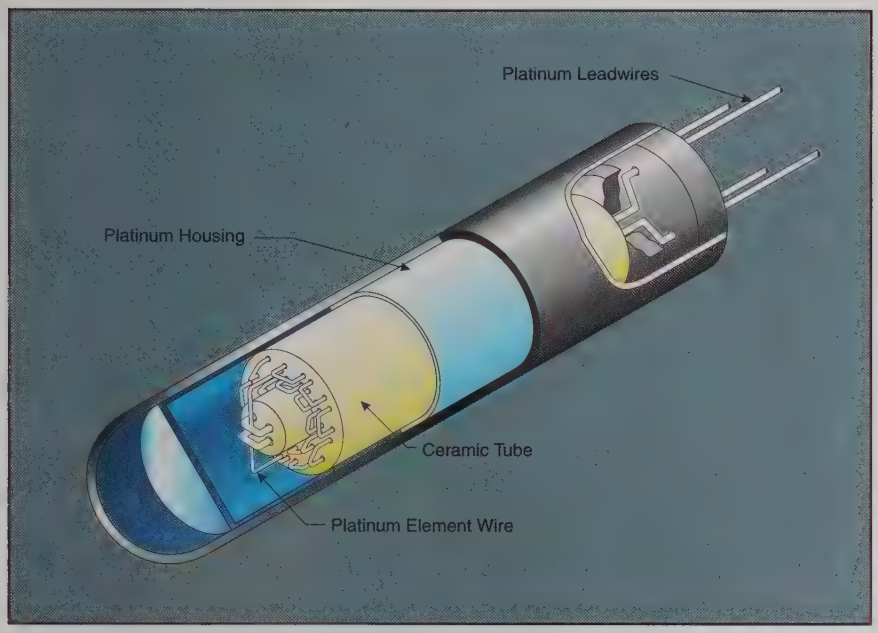
The insulation resistance from the platinum resistor to the outside sheath is greater than 5000 megohms at 100 VDC and room temperature.

Response

The response of the resistor is less than 3 seconds when immersed in 77°C water moving at 3 feet per second from 23°C ambient air. Response is defined as the time required for the resistor to reach 63.2 percent of a stop change in temperature.

Resistance-Temperature Relationship

This thermometer is perfect for ITS-90 work. The nominal resistance at 0°C is 25.55 ohms and varies from 4.3 ohms at –200°C to 86.4 ohms at 661°C. A slope of approximately 0.1 ohms/°C allows for convenient interpolation.



Platinum Resistance Sensing Element.

Storage Case

Each Model 162CE comes in its own oak storage case. The shipping container is reusable for shipping the thermometer back for recalibration. Everything about this unit is of the finest quality.

Calibration

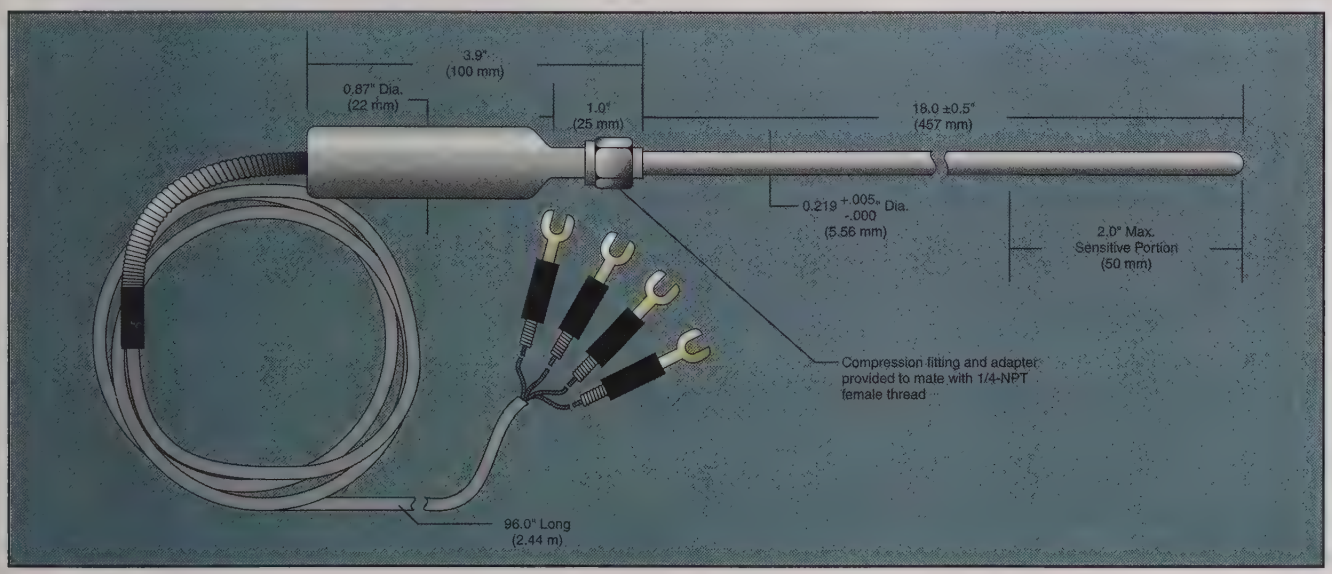
Hart offers three calibration options. Each thermometer can be calibrated in Hart's lab using comparison methods or fixed-points, in Rosemount's calibration lab, or sent to NIST for calibration. Each option is separately priced. See page 8 for our calibration prices or call us to discuss other calibration options.

Now you can combine the best calibration instruments available in one easy order. Get all your temperature calibration needs met from one source. Nobody does it like Hart. Nobody does it better.

Ordering Information:

5687 SPRT 162CE **$3,528**

(Order calibration separately.)



162CE Dimensions

ROSEMOUNT® MODEL 162D CAPSULE SPRT

Rosemount	Model 162D
Range is –260°C to 250°C	
Stability better than ±0.01°C per year	
Rugged metal sheath and miniature size	

If your application requires a standard smaller than the typical longstem SPRT the Rosemount 162D meets ITS-90 requirements for measurements from -260°C to 250°C and it's less than 2 inches long. This standard combines ruggedness with accuracy and offers low self-heating, an INCONEL X-750™ sheath, insenstivity to pressure and a hermetically sealed platinum resistor.

The 162D's miniature capsule design minimizes conduction errors in cryogenic and other applications. The uniform external diameter makes the capsule easy to install in copper blocks, cryostats and other calibration fixtures.

The strain free, fully annealed element is encased in a platinum alloy inner housing and hermetically sealed in the sheath with an inert helium atmosphere for long-term stability. Use the 162D in any nonconductive fluid media that is compatible with INCONEL, platinum, gold and glass.

Like the other Rosemount thermometers, the 162D comes in an attractive oak case for protective storage and transportation.

Specifications Model 162D

Range: –260°C to 250°C

Stability: Better than 0.01°C over full range, typically 0.001°C per year over a nominal 100 C range

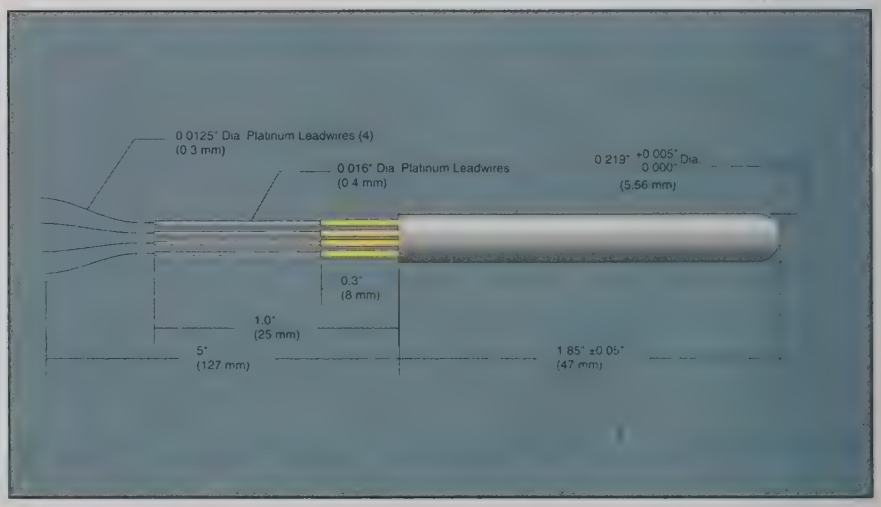
Self-heating: <0.002°C in copper block in stirred ice bath, nominally 0.0003°C at 1mA current

Nominal R_0 Value: 25.55Ω

Resistance Ratio: W(234.3156K)≥ 0.844235; W(302.9146K)≥1.11807

Ordering Information:

5688 Capsule SPRT 162D **$2,925**
(Order calibration separately.)



162D Dimensions

ROSEMOUNT® MODEL 162K HIGH TEMP SPRT

Rosemount	Model 162K
Proven design for use at the ITS-90 point of 961.78°C	
Drift rate less than 0.01°C per 100 hours	
Range 0°C to 1100°C	

The Rosemount 162K meets ITS-90 requirements for primary standard performance at the Silver Point (961.78°C). The high stability design of the 162K typically drifts only 0.002°C after 100 hours at 962°C for excellent overall calibration accuracy.

The standard's resistor is formed from a highly purified platinum wire and supported virtually strain-free by an insulator tube and disk in a "birdcage" design. All 4 leadwires connecting the element to the housing are annealed platinum, insulated by quartz tubes. The element is hermetically sealed in a quartz sheath containing an argon-oxygen atmosphere. A matte finish is applied to the quartz sheath to minimize errors due to radiation heat losses.

The quality crafted construction is completed by a stainless steel rear housing with a strain relieved connection to an 8-foot vinyl jacket cable. Heavy gold-plated spade lugs terminate the 4 lead wires. Each thermometer comes in a padded oak carrying case.

Specifications Model 162K

R_0 Drift Rate: <0.010°C per 100 hrs at 1100°C

Self-Heating: <0.003°C in stirred ice bath, nominally 0.002°C

Current: 10mA

Insulation Resistance: 1000 megohms at 100 VDC at 25°C; 1 megohm at 1 VDC at 1064°C

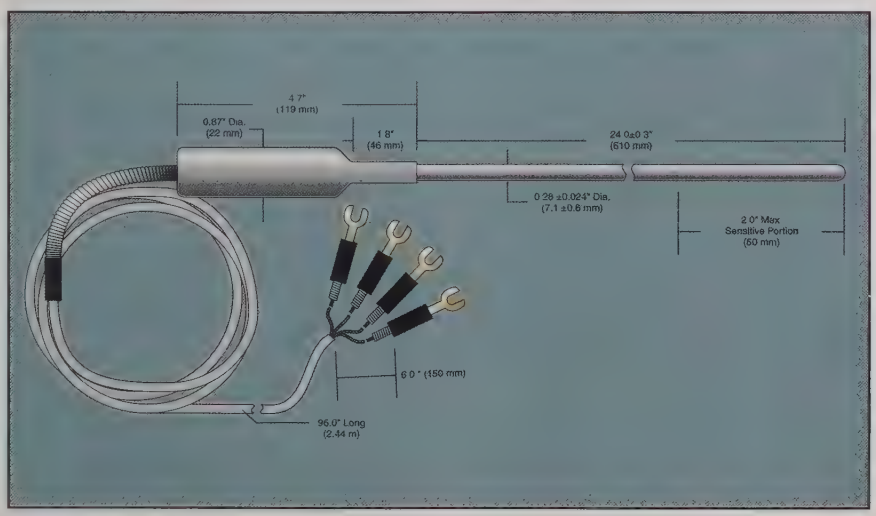
Resistance: R_0 value is between 0.20 and 0.25 ohms

Resistance ratio exceeds minimum ITS-90 requirement of 1.11807 at the melting point of Gallium and 4.2844 at the Silver Point.

Ordering Information:

5689 HTPRT 162K **$5,096**

(Order calibration separately.)



162K Dimensions

CHINO SPRTs

Chino SPRTs	Model 5602/5603/5604
Conforms to ITS-90	
Drift rate less than 0.001K annually	
Optional calibration choices	

Hart Scientific is pleased to offer its customers the Chino line of precision Standard Platinum Resistance Thermometers.

These thermometers were developed under the guidance of the National Research Laboratory of Metrology (NRLM) of Japan and have been accepted throughout the world as excellent interpolation standards for both IPTS-68 and ITS-90. Both NIST and the CCT (*Comite Consultatif de Thermometrie*, the international committee that establishes the temperature scale) use these thermometers.

The 5602, 5603 and 5604 all have a thermometer element made by winding a platinum resistance strand onto a cross-frame using the double coil system and then housing the element in a quartz sheath.

Each quartz sheathed model is composed of the thermometer element, convection prevention plate, spacer and internal wire connected to 4-conductor external leads with gold-plated terminals. The leak resistant assembly is pressure sealed with dry air. The convection prevention plate reduces stem errors due to thermal radiation or conduction.

All Chino SPRTs come with a durable, high quality wooden storage and transport case to protect the thermometer. All of these Chino products use the finest materials and best construction techniques possible.

The new International Temperature Scale of 1990 (ITS-90) defines a new interpolation standard for use up to the Silver Point (961.78°C), replacing the type S thermocouple over that range. Both 0.25 ohm and 2.5 ohm thermometer designs are mentioned in the guidelines for the new scale. Hart offers both thermometer resistances but with additional temperature capability to the Gold Point (1064.18°C).

The Chino thermometers are priced without calibration. Hart offers several calibration choices. You can calibrate the thermometers in your own lab or ship them directly to NIST yourself, depending on your preference. Option 3 is a fixed-point calibration by Chino. This calibration employs the fixed-points of ITS-90 and meets international traceability requirements. Option 4 is a comparison calibration by Hart Scientific using a NIST calibrated SPRT. Fixed-point calibration is also available from our lab. See page 8 for details.

Each calibration option is priced separately and designed to give you the price and performance combination you need most.

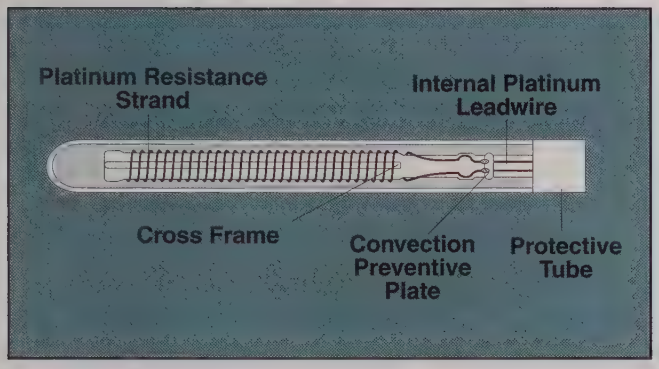
Study the specs on each thermometer and see if you don't agree these are the best SPRTs you can buy.

In addition, if you want to combine these fine quality sensors with other Hart instrumentation, we can give you exact performance specs, system accuracies and application information. When you buy from Hart, you know exactly what to expect in your equipment.

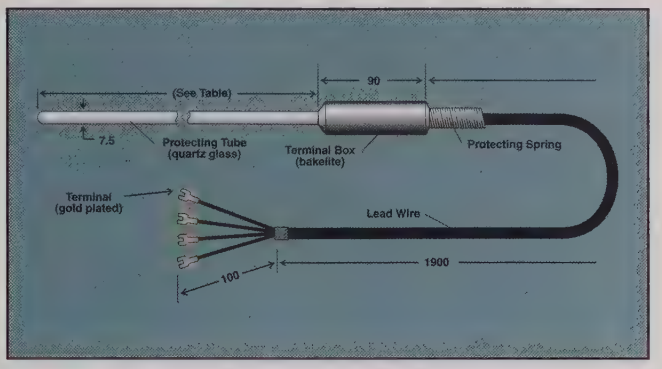
Ordering Information:

5602 SPRT 25.5Ω, 962°C	**$6,600**
5603 SPRT 2.5Ω, 1065°C	**8,000**
5604 SPRT 0.25Ω, 1065°C	**8,600**

Call for calibration prices.



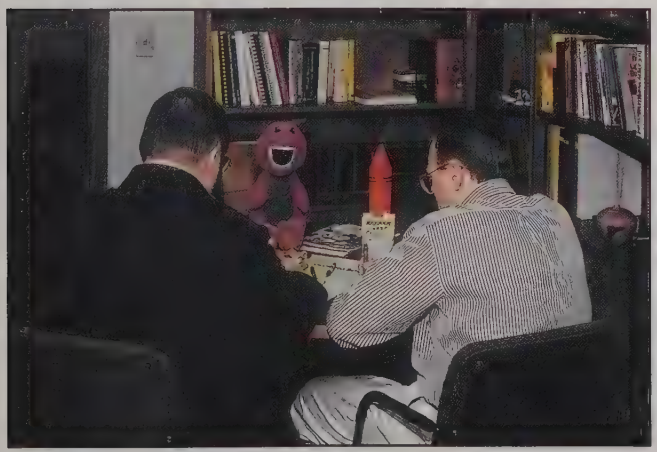
5602, 5603 and 5604 Thermometer Construction.



5602, 5603 and 5604 Thermometer Dimensions (in mm).

Specifications

Model	5602	5603	5604
Measuring Temperature Range	90.188K to 961.93°C	90.188K to 1064.43°C	
Resistance Value	25.5Ω at 0°C	2.5Ω at 0°C	.25Ω at 0°C
Specified Current	1 mA DC	1 mA DC	1 mA DC
Temp. Characteristic	R(100°C)/R(0°C) ≥ 1.32950	R(100°C)/R(0°C) ≥ 1.32950	
Reproducibility	±0.1 mΩ (±0.001K) or better	±0.02 mΩ (±1 mK) or better	
Sensitivity	0.1Ω/K	0.01Ω/K	0.001Ω/K
Self-Heating	Within 0.001K	2 mK/10 mA	
Drift Rate	0.1 mΩ/year (0.001k/year) when employed at 90.188K – 630.74°C (about 0.002K/h at 631°C – 850°C, about 0.003K/h at 850°C – 960°C)	±0.01°C or less/100 hours at lower than 800°C; ±0.01°C or less/100 hours at 800°C – 1065°C	
Sealed Gas	Dry air	Dry air, 1/3 atmospheric pressure	
Connecting Internal Lead	Platinum wire	Platinum wire	
Connecting External Lead	4-conductor cabtyre cord 2 m with gold-plated terminals	4-conductor cabtyre cord 2 m with gold-plated terminals	
Frame	Cross-type transparent quartz	Cross-type transparent quartz	
Protecting Tube	Quartz tube (7.5 ±0.5) mm ϕ × 600 mm L	Quartz tube (7.5 ±0.5) mm ϕ × 800 mm L	



The Chairman and President are working on the new color catalog. Busy hands are happy hands. We've heard them singing Barney songs too.

YSI 8163 SPRT	Model 5675 /5676
A long time favorite of many labs	
Manufactured by Yellow Springs Instruments	
Includes cushioned carrying case	

In an effort to bring you the most complete line of fine quality temperature calibration tools in the industry, Hart is pleased to offer you the YSI SPRT in addition to the other excellent instruments we have in the catalog.

The YSI SPRT is the same SPRT originally made by Leeds and Northrup and built by YSI since 1981. This 4-lead thermometer is highly stable over long periods of time. Resistance is about 25.5 ohms at 0°C; the temperature coefficient of resistance is higher than 0.003925 ohms/ohm/°C, which meets the interpolation standard of ITS-90.

Two models are available. Model 5675 has a time constant of 6 seconds and Model 5676 has a time constant of 3.5 seconds. Both units measure from --200°C to 650°C. Each Model may be ordered with a calibration from YSI or Hart Scientific depending on your preference. We recommend a fixed-point calibration up to the Zinc Point (419.527°C).

These YSI SPRTs are fine temperature standards. We've used and calibrated most types. We know the quality, the performance and the difference between the thermometers we offer to you. Call us and we'll help you find the one that's right for your work.

Specifications:

Range: –200°C to 650°C

Resistance: 25.5Ω at 0°C

Coefficient of Resistance: 0.003925 Ω/Ω/°C

Protection Tube: Quartz

Sensitive Portion: 0.290" OD max. (7.36 mm) 1.31" L (33.33 mm)

Filled With: Dry Air

Immersion: 7" min. (177.8 mm), 14" max. (355.6 mm)

Response Time:
5675: 15 sec.
5676: 8 sec.

Time Constant:
5675: 6 sec.
5676: 3.5 sec.

Leadwire: 4-lead flexible copper cable, 8 ft (2.43 m) long, with gold-plated lugs.

Ordering Information:

5675 SPRT 8163-Q	**$3,800**
5676 SPRT 8167-25	**4,780**

WHY USE A TRIPLE POINT OF WATER

The international temperature scales are defined mainly based on a number of specified thermal equilibrium states—temperatures that are defined and recognized by a physical phenomena occuring at a specific temperature. These thermal states are generally referred to as fixed-points.

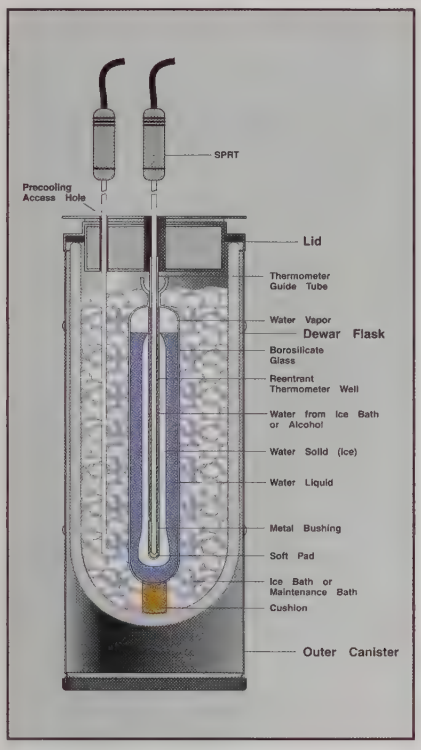
Fixed-points, sometimes called intrinsic standards, are used to define the International Temperature Scale of 1990 (ITS 90). The most commonly used fixed-point is the Triple Point of Water (TPW). A Triple Point of Water Cell is used to create a thermal equilibrium between the three phases of pure water: liquid, solid and gas. This thermal equilibrium occurs at 273.16 Kelvin, or 0.01° C.

The TPW temperature value has not changed in the development and implementation of IPTS-48, IPTS-68 and now ITS-90. In proper use, the Triple Point of Water Cell achieves an uncertainty of 0.0002°C.

If you use SPRTs, the Triple Point of Water Cell is your most important fixed-point because ITS-90 specifies the interpolation equations of an SPRT based on its resistance ratio stated as W(t)=R(t)/R(0.01°C), thus requiring you to measure the resistance of your SPRT at the TPW frequently. Directly measuring R(0.01°C) in a triple point of water cell reduces most of the error caused from the instability of an SPRT.

Hart's Triple Point of Water Cell is a cylindrical borosilicate glass container filled with water and having a re-entrant tube serving as a thermometer well. The water in the cell is of high purity, gas free and has the isotopic composition of sea water. The equilibrium temperature is measured at the ice-water interface surrounding the thermometer.

Like all calibration instruments, Triple Point of Water Cells have an uncertainty. Hart Cells achieve an expanded uncertainty of 0.0002°C or less.



Triple Point of Water Cell in an Ice Bath Dewar.

Triple Point Cells are not the only means of achieving a 0°C reference temperature. Ice baths are an alternative, and if done properly produce a temperature of 0.0°C.

An ice bath, for use as a reference, is made with chopped up ice in a dewar flask. The flask should be 36 cm deep and 8 cm in diameter. Shaved ice and distilled water are then added to the flask and allowed to reach a constant temperature. To avoid vertical or radial temperature gradients, distilled water must fill all of the crevices between the ice chips. Ice chips should be 2 to 5 mm in diameter and must be free of contaminates. As shown from these steps, ice baths are relatively easy to make and inexpensive. Ice baths, however, have several limitations including gradients throughout the bath, potential purity problems, repeatability issues and variances in individual construction and measurement techniques.

TPWs address many of the problems of ice baths. With the high purity water in a sealed cell, contamination worries are eliminated. The cell operates free of atmospheric pressure and forces proper operator technique for thermal equilibrium to occur.

Cells are delicate and must be handled with care. However, cells are inexpensive and give confidence in measurement accuracy and repeatability. A new cell design with wider openings at the top of the re-entrant tube and a rubber shock absorber on the base make Hart Water Triple Point Cells more durable than ever.

Triple Point of Water Cells are fundamental calibration instruments for many labs. Platinum resistance thermometers require the determination of the resistance at 0°C for input into linearization equations. And periodically the zero point is used as a certification check on the thermometers. In general, if the resistance at the TPW has not changed, the thermometer does not need recalibration.

Liquid-in-glass thermometers use 0°C as a verification point. And TPWs sometimes serve as precision reference junctions for thermocouples.

Labs that have a large number of zero point calibrations or checks to perform, maintain the cells at 0°C using a chilled liquid bath such as Hart's Model 7012. For use over a few hours, an ice bath dewar is adequate. The combination of an ice bath dewar and a Triple Point of Water Cell yields the highest accuracy, lowest cost combination for any primary standard used in the calibration industry.

In addition, learning to use a TPW is a simple hands-on process. So what this adds up to is: absolute precision for a very low purchase price and a short learning curve. This is absolutely the lowest cost, primary standards instrument available.

TRIPLE POINT OF WATER CELL — Model 5901

The Triple Point of Water Cell is one of the finest, most cost effective temperature standards available for the lab. It is the most important fixed-point, and the only fixed-point for both the ITS-90 temperature scale and the thermodynamic temperature. Its temperature value has not changed in the development and implementation of IPTS-48, IPTS-68 and now ITS-90. In proper use the Triple Point of Water Cell achieves an uncertainty of 0.0002°C.

If you use SPRTs, the Triple Point of Water Cell is your most important fixed-point because ITS-90 specifies the interpolation equations of an SPRT based on its resistance ratio stated as W(t)=R(t)/R(0.01 C), thus requiring you to measure the resistance of your SPRT at the triple point of water frequently. Directly measuring R(0.01°C) in a Triple Point of Water Cell reduces most of the error caused from the instability of an SPRT.

Hart's Triple Point of Water Cell is a cylindrical borosilicate glass container filled with highly pure water. The water in the cell is gas free with an isotopic composition equivalent to seawater. The cell has a reentrant tube for the thermometer well.

If you need more than one cell, or constant access to a Triple Point, Hart's Model 7012 refrigerated bath maintains up to five cells at their thermal equilibrium state.

Hart metrologists not only design and manufacture these cells, they use them in Hart's temperature calibration lab. They know every aspect of the cell and have used it with almost every SPRT manufactured. You can't beat experience like that.

Hart guarantees an expanded uncertainty of 0.2mK in its Triple Point of Water Cells for 4 years. Nothing beats the cost effectiveness of the Triple Point of Water Cell.

Specifications

Expanded Uncertainty: 0.0002°C

Reproducibility: 0.00005°C

Dimensions:

Outside Diameter: 60 mm
Inside Diameter: 11–12 mm
Overall Length: 340–360 mm

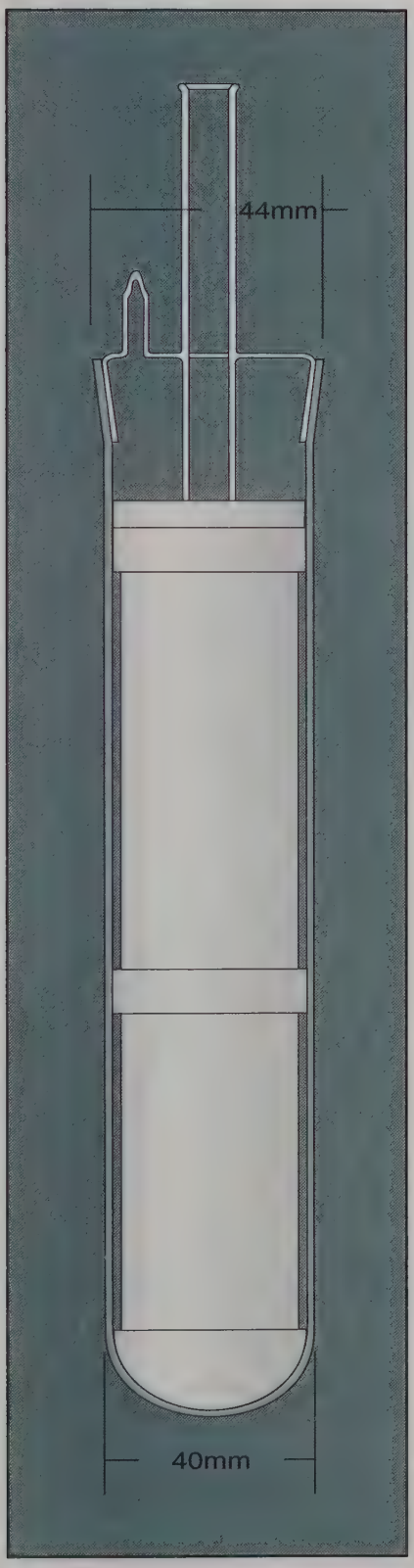
Ordering Information:

5901 Triple Point of Water Cell	**$950**
2028 Ice Bath Dewar for 5901	**995**

The Hart 7012 bath can maintain five cells at the 0°C point continuously. See page 66 for a complete description of the 7012 bath.

7012 TPW Maintenance Bath	**7,900**
2027-5901 Holding Fixture	**600**

GALLIUM MELTING POINT CELL — Model 5903



The melting point of gallium (M.P.Ga) at 29.7646°C is one of the defining fixed-points of ITS-90. Its temperature is in the range of room temperature making it an important calibration point in biological, environmental, oceanographic, geological and energy research instruments. It is also an excellent reference for validation of instruments subject to drift like SPRTs.

ITS-90 specifies two subranges: one from 0°C to 29.7646°C and from 38.8344°C to 29.7646°C. Therefore, a check of R_{tp} in a water triple point followed by a measurement at the gallium melting point to determine the W_{Ga} is generally sufficient to prove continued certification of a thermometer's most recent calibration.

Hart's Gallium Melting Point is sealed in a quartz glass envelope. Pure gallium (99.99999%) is enclosed in a plastic-glass shell under vacuum. The quartz container is then filled with argon gas at one standard atmosphere at the melting point temperature. Gallium expands on freezing by 3.1% requiring the cell to have flexible walls. Some gallium cells are made from PTFE, which is gas-permeable over time thus requiring frequent pumping and refilling. Many national labs use PTFE cells in this fashion, especially in research.

Completely sealed PTFE cells may solve the convenience problem; however, after 4 years some degraded by 0.5 mK because of gas penetration. Hart cells do not have these problems due to the new materials and design technology incorporated into the Model 5903 Gallium Melting Points. Hart's cells maintain their uncertainty for at least 5 years or more.

If you're calibrating thermometers that have a range limited to approximately room temperature, this is the best standard to work with. Because thermometers change their characteristics more at higher temperatures, they should be calibrated as near their operating range as possible.

You can hold a stable melting plateau from 10 hours to more than 2 days depending on the techniques you use to maintain the cell. Hart bath Models 7012 and 7037 with the Model 2027 Cell Holder increase the life of the melting plateau substantially and make using M.P.Ga easy and efficient.

Call Hart today for more information and applications assistance on primary standards.

Specifications — Model 5903

Reproducibility: 0.06mK–0.1mK (0.00006°C–0.0001°C)

Expanded Uncertainty: 0.2mK–0.4mK (0.0002°C–0.0004°C)

Gallium Purity: 99.99999%

Outer Diameter of Cell: 40 mm ±0.5 mm

Overall Height of Cell: 240 mm

Inner Dia. of Thermometer Well: 8.0 mm ±0.5 mm (other dia. available on special order)

Ordering Information:

5903 Gallium Melting Point Cell	**$6,590**
2027-5903 GaMPC Holder	**600**
7012 Bath	**7,900**

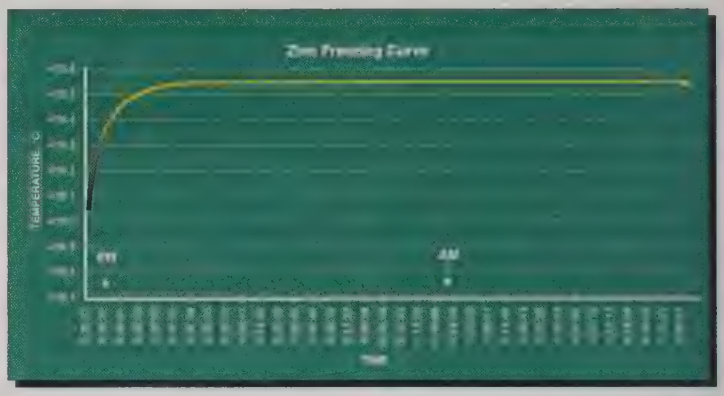
METAL FREEZE POINT CELLS

The ITS-90 temperature scale is based on a series of defining fixed-points, most of which are the freeze points above 273.16 Kelvin. High purity metals such as: indium, tin, zinc, aluminum, silver, gold and copper make good freeze points. Pure metals melt and freeze at a unique temperature through a process involving the absorption or liberation of the latent heat of fusion.

Modern technology permits measurement of temperature changes as small as 0.00001°C (0.01 mK). Since it is impossible to get a 100% pure metal, the metals used in freeze point cells don't melt and freeze at one single temperature, but vary slightly from their theoretical absolute point. The best freeze point cells are ones that get very close to their theoretical temperature while providing a temperature plateau that is stable and long lasting for calibration work.

Hart metrologists have designed and tested metal freeze point cells for many years and have developed manufacturing techniques and designs for producing consistent, quality cells with performance equaling or exceeding all of the best cells in the world. Radiation losses along the well have been accounted for, possible stem error has been minimized and pressure corrections have been made for precision cell construction.

The table below lists the cells Hart manufactures with their freezing points and other critical data. The hydrostatic head pressure in a cell causes a small change in the equilibrium temperature that should be applied to the measurements as part of the calibration process. The table also states the reproducibility and expanded uncertainty of each type of cell.



The immersion depth of a thermometer in the liquid metal (the distance from the surface of the liquid metal to the middle point of the thermometer's sensor) is approximately 180 mm in cells made by Hart.

Each cell has to be used and maintained in specially designed freeze point furnaces. Furnaces come in a variety of temperature ranges and each one must have a very uniform temperature region for the freezing and melting process. High accuracy is achieved by the formation of two liquid-solid interfaces during freezing. One should be adjacent to the inner surface of the crucible and the other should be on the outer surface of the central well, which is the closest point to the thermometer. A very thin solid shell should form on the central well, and the concentration of impurity in this thin shell should be much lower than the average impurity in the core metal. The temperature on the second liquid-solid interface should be extremely close to that found in a 100% pure metal under ideal conditions.

Hart's freeze point furnaces provide the proper temperature, stability and uniformity to create the longest, most stable temperature plateau possible. The graph above illustrates this point with a zinc freezing curve. The freeze plateau lasted more than 14 hours and the change in temperature in the first 10 hours was within ±0.0002°C. This plateau provides ample time for several calibrations in a row.

Cells are delicate and must be handled with extreme care. Hart provides special storage cases, gloves for handling and complete care instructions. Cells are hand-carried rather than shipped to insure complete integrity of measurements.

The outside diameter of each cell is 48 mm, the thermometer well is 8 mm, cell length is 290 mm and thermometer immersion depth is 190 mm. Hart warrants all metal freeze point cells for one year against defects, purity problems and measurement uncertainty. Breakage is not covered.

Model Number	The Fixed-Point	Assigned Value of Equilibrium Temperature (°C)	Temperature with Pressure, p (dT/dp) (10-8 K/Pa)	Variation with Depth (mK/m)	The Correction for the Hydrostatic Head (mK)	Reproducibility (mK)	Expanded Uncertainty† (mK)
5904	F.P. In	156.5985	4.9	3.3	+0.59	0.15–0.3	0.5–1.0
5905	F.P. Sn	231.928	3.3	2.2	+0.40	0.2–0.4	0.7–1.4
5906	F.P. Zn	419.527	4.3	2.7	+0.49	0.2–0.4	0.8–1.6
5907	F.P. Al	660.323	7.0	1.6	+0.29	0.6–1.0	2.5–5.0
5908	F.P. Ag	961.78	6.0	5.4	+0.97	1.0–2.0	3.5–7.0
Call	F.P. Au	1064.18	6.1	10	+1.8		
5909	F.P. Cu	1084.62	3.3	2.6	+0.47	2.0–4.0	7.0–15

†The expanded uncertainty was evaluated to be at a level of 2 times the combined standard uncertainties.

METAL FREEZE POINT CELLS

Ordering Information:

5904 Indium, 156.5985°C	**$12,500**
5905 Tin, 231.928°C	**8,800**
5906 Zinc, 419.527°C	**7,800**
5907 Aluminum, 660.323°C	**8,900**
5908 Silver, 961.78°C	**13,900**
5909 Copper, 1084.62°C	**9,700**

See pages 24–28 for Hart's freeze point furnaces.

Hart Scientific is now offering metal freeze point cells manufactured in Utah. In response to a number of customer requests, we offer sealed, fixed-point cells that are suitable for use in the primary standards laboratory. Hart's cell design has been proven in the international standards community and uncertainty levels are of the order expected in national laboratories.

The completely sealed cell eliminates hassles with pressure corrections and gas handling. The cell is pumped out to high vacuum and then pure argon (99.999%) fills the cell to a pressure of approximately 101.325 kPa at the temperature of the freezing point. The high purity metal samples are contained in a dense, highly pure graphite crucible.

The Indium, Tin , Zinc, Aluminum and Silver Cells are sealed in a pure quartz envelope. The outside diameter of each cell is 48 mm, the thermometer well is 8 mm, cell length is 290 mm and the thermometer immersion depth is 190 mm.

Hart warrants all metal freeze point cells against defects for one year, other than accidental breakage of the graphite crucible and quartz envelope.

Hart now has many cells in stock. For Gold or other cells, please call. Hart is the leading manufacturer of temperature calibration equipment. We're the only calibration company manufacturing metal freeze point cells in America.

Call Hart for applications information, questions or just to talk about temperature calibration in general. Visit our plant and test our cells in our calibration laboratory. You can make the trip in only one day from anywhere in the United States. Hart's quality, price, complete package, convenience, and location make the difference.

METROLOGY FURNACE

Metrology Furnace	Model 9114
Most advanced Metal Freeze Point Furnace available	
Optional equilibration block for comparison calibrations	
Stability better than ±0.03°C	
Range of 100°C to 680°C covers up to the Aluminum Point	
Three zone design minimizes vertical gradients	

If you're buying a new primary standards furnace for your lab or if you want the highest quality comparison calibration furnace available, the Hart Model 9114 is the best furnace you'll find anywhere in the world.

It covers the range of 100°C to 680°C, so it's perfect for Indium, Tin, Zinc and Aluminum Cells. The Model 9114 is cost effective. It handles all of the most widely used freezing point cells. You won't need one furnace for Indium, Tin and Zinc Cells and a higher temperature furnace for Aluminum Cells. This means less lab space, lower cost and less maintenance. For comparison calibrations without a metal freeze point, call us for a furnace equilibration block suitable for your SPRTs.

The 9114 is a 3-zone furnace featuring the latest in microelectronic digital/analog controller technology for minimal gradients and maximum stability. The controls are located at the top of the unit for easy access and best visibility.

The primary furnace heater is wound over the entire length of the block. The upper and lower zone heaters are wound only on the top and bottom ends of the furnace core. They assist in bringing the core into temperature equilibrium across its entire length. The combination of Hart's controller technology and this heater configuration tightly controls vertical gradients and produces a stability of ±0.03°C.

Because Hart's engineering group has more years of experience in primary standards, heating technology, and control design than any other company in the world, no one else can bring you better furnace technology.

The primary controller is setable in 0.01°C increments, and actual temperature is read to two decimal places. The freezing and melting processes are automatable using eight preset user programmable temperature settings. The top and bottom zones are slaved to the primary zone using differential thermocouples. A high temperature PRT acts as the main control sensor for the best accuracy, sensitivity and repeatability possible.

The top panel of the furnace lifts off for replacement of controller sensors. Heater fuses and zone controls are directly behind the control panel door for easy, fast access.

With the optional RS-232 or IEEE-488 interfaces, you can control your 9114 furnace with a PC, allowing semi-automated freeze point measurements or precise comparison calibrations under computer control.

Each furnace includes an inert gas or dry air inlet. Gas can be used to supercool the tin cell for initiation of the freeze plateau without removing the cell from the furnace.

The Hart Model 9114 furnace is a great metal freeze point furnace or, with an equilibration block, the best furnace available for SPRT comparison calibrations.

Specifications Model 9114

Temperature Range: 100°C to 680°C

Temperature Stability: ±0.03°C or better

Temperature Gradients: less than ±0.3°C in the block, ±0.05°C in the bottom 6" of a cell.

Setpoint Accuracy: ±0.5°C

Setpoint Resolution: 0.01°C

Display Resolution: 0.01°C

Thermal Safety Cutout Accuracy: ±10°C

Heater Power: End Zones = 1,000 watts each (@ 230 VAC nom.), Primary Zone = 1500 watts

Exterior Dimensions: 33" H x 24" W x 16" D (838 mm x 610 mm x 406 mm)

Power Requirements: 208 to 245 VAC, 50/60 Hz, 1 Phase, 22 Amps maximum

Weight: 150 lbs. (68 kg)

Ordering Information:

9114 Metrology Furnace	**$17,500**
2122 RS-232 I/O	**295**
2125 IEEE-488 I/O	**395**
2940 Cell Support Container	**420**

Call for custom blocks for comparison calibrations.

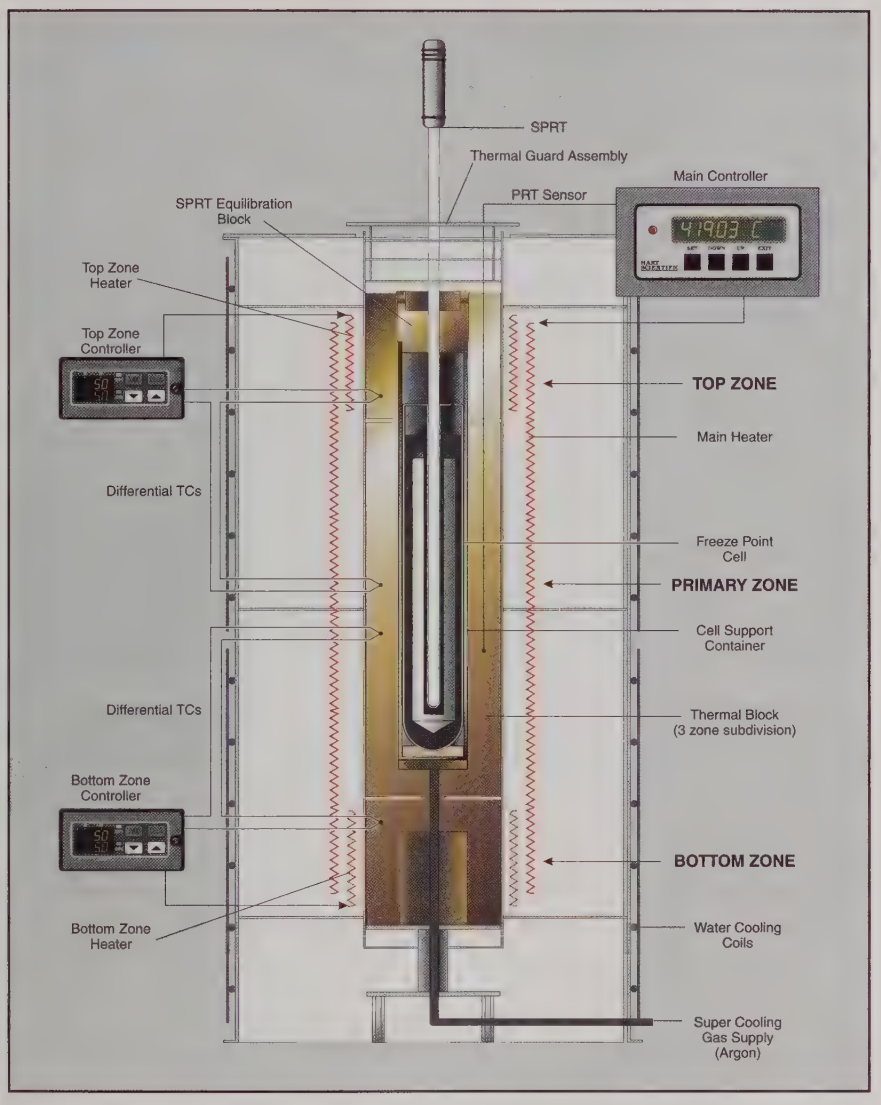


Diagram of Internal Block of 9114 Furnace.

SODIUM HEAT PIPE FURNACE — Range 550°C to 1000°C

Sodium Heat Pipe Furnace	Model 9115
Minimum gradients	
Long plateaus	
External cooling coils	

The Model 9115 Sodium Heat Pipe Furnace is specifically designed for maintenance of Aluminum and Silver Freeze Point Cells.

It has a temperature range of 550°C to 1000°C with gradients of less than 0.1°C throughout. The sodium heat pipe design provides a simple yet uniform single heating zone that ensures very uniform changes in states during heating and cooling.

The furnace is programmable through its controller. Melting, freeze initiation and plateau control for a variety of freeze point cells is possible by inputting up to 19 programs for set points and ramp and soak rates. The controller displays temperature in °C, F or K and temperature feedback is done via a type S thermocouple. Freeze point plateaus of 8 to 10 hours are typical and 24 hours is possible under controlled conditions. Two preheat wells prep the SPRT to minimize its insertion impact when placing it in a freeze point.

External cooling coils are standard for circulation of tap water at less than 60 PSIG and approximately 4 GPM to control chassis temperature when necessary for prevention of heat load to the environment. Temperature cutouts protect your SPRTs and the furnace from exposure to excessive temperatures.

Hart Scientific manufactures freeze point cells and furnaces for your metrology work. When you have to depend on your instruments, you can depend on Hart.

Specifications

Range: 550°C to 1000°C

Set Point Resolution: 1°C

Display Resolution: 0.1°C

Cutout Accuracy: ±10°C

Heater Power: 2500 watts

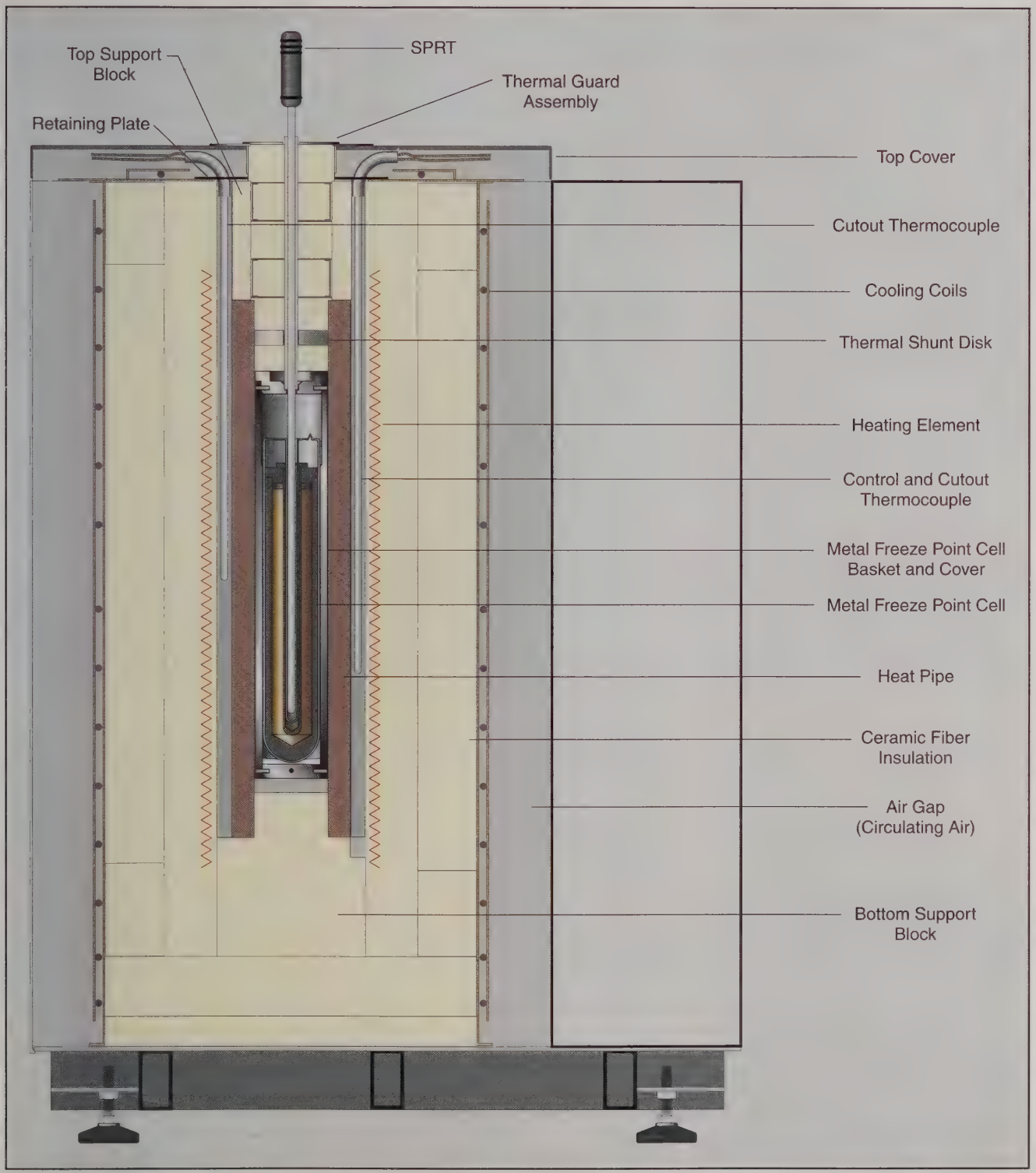
Exterior Dimensions: 33" H x 24" W x 16" D (838 mm x 610 mm x 406 mm)

Power: 208-245 VAC, 50/60 Hz, 1 phase, 12 amps max.

Weight: 130 lbs. (59 Kg)

Ordering Information:

9115 Sodium Heat Pipe Furnace	**$19,800**



9115 Furnace Interior with Freeze Point Cell, Cross Sectional View.

SINGLE ZONE FREEZE POINT FURNACE — Range 500°C to 1100°C

Single Zone Freeze Point Furnace	Model 9116
Uniform temperature	
Long-term stability	
External cooling coils	

Hart Scientific manufactures a complete line of metal freeze point cells and the furnaces necessary to maintain them. This year we're adding the Model 9116 Single Zone Furnace for temperatures up to 1100°C sufficient for Copper fixed-point maintenance.

In addition to Copper, this furnace is also excellent for Aluminum, Silver, and Gold fixed-points, the ITS-90 group of freeze point standards.

The temperature along the single zone is uniform and stable providing the longest temperature plateaus possible. Its PID controller accepts 19 different program patterns having individual set points and ramp/soak rates. Temperature is displayed in °C, °F or K.

External cooling coils are standard and assist in the reduction of heat loading effect in the laboratory if necessary. Normal tap water circulated at less than 60 PSIG and 0.4 GPM controls the chassis temperature.

Freeze point plateaus of 8 to 10 hours are normal and 24 hours is possible under proper lab conditions.

The Model 9116 is another excellent metrology product from Hart. Call us to discuss any freeze point application you have.

Specifications

Range: 500°C to 1100°C

Set Point Resolution: 1°C

Display Resolution: 0.1°C below 1000°C; 1°C above 1000°C

Cutout Accuracy: ±10°C

Heater Power: 2645 watts

Exterior Dimensions: 33" H x 24" W x 16" D (838 mm x 610 mm x 406 mm)

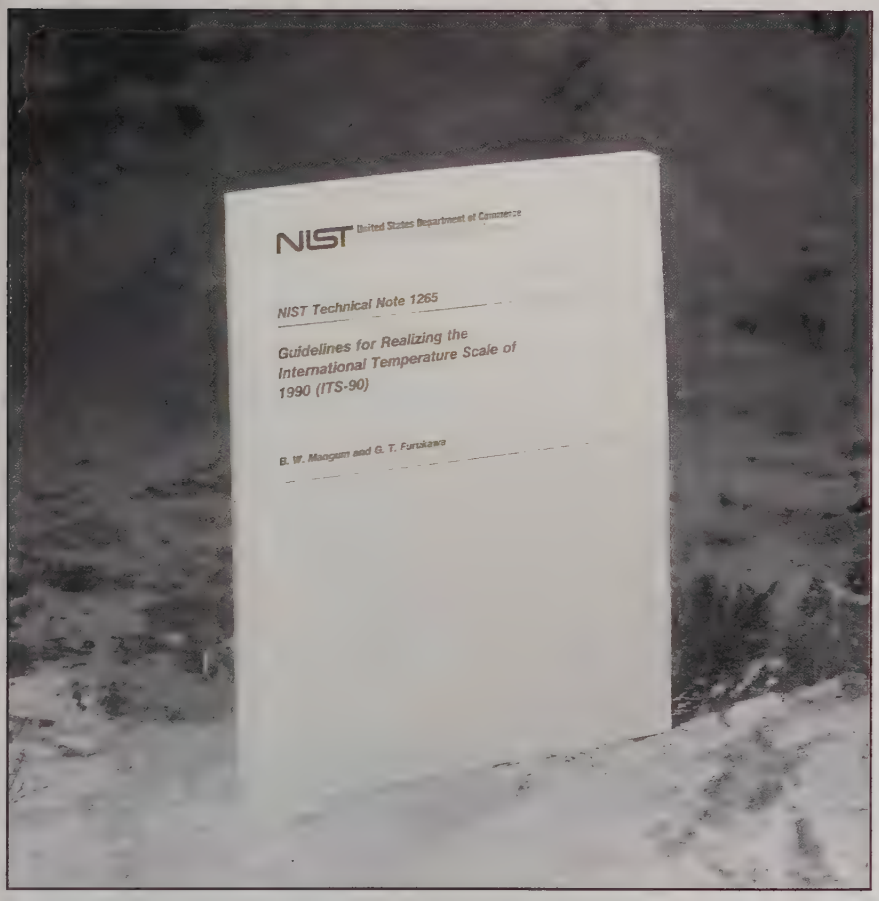
Power: 208-245 VAC, 50/60 Hz, 1 Phase, 12 amps max.

Weight: 116 lbs. (53 Kg)

Ordering Information:

9116 Single Zone Furnace **$19,600**

ITS-90 GUIDELINES


NIST United States Department of Commerce
NIST Technical Note 1265
Guidelines for Realizing the International Temperature Scale of 1990 (ITS-90)
B. W. Mangum and G. T. Furukawa

Have you received your copy of NIST's ITS-90 guidelines, "NIST Technical Note 1265, Guidelines for Realizing the International Temperature Scale of 1990 (ITS-90)" by B. W. Mangum and G. T. Furukawa?

On January 1, 1990 the International Temperature Scale of 1990 became the official international temperature scale, superseding the previous scale, IPTS-68. Are you prepared for ITS-90? Do you know how it's going to affect your calibration work or what the impact of ITS-90's going to be when it's time to recertify your calibration instruments? This official NIST book tells you and Hart Scientific makes it easy to get.

We'll send you as many copies as you need for $35 each, including postage and handling.

This book tells you the difference between ITS-90 and IPTS-68. It also explains the difference between IPTS-68 (75) and the 1976 Provisional 0.5 K to 30 K Temperature Scale (EPT-76). Measurement procedures for realizing ITS-90 throughout the temperature scale are given.

Also, for the most important temperature region, the platinum resistance thermometer (PRT) region, computational examples are included for determining the coefficients of the relevant deviation equations for PRTs calibrated at various sets of fixed-points.

In addition, you get reproductions of articles and document excerpts involving ITS-90 discussions and decisions. If you calibrate temperature sensors or instruments, you need this comprehensive guideline.

To order, call us at 1-800-438-4278 or fax us at 1-801-785-7118.

Don't wait. Get your copy today! It's as easy as picking up the phone.

Ordering Information:

9399 NIST Tech. Note 1265 **$35**

Here's a picture of our new building. Well, almost!

INTRODUCTION TO THERMOMETRY

Comparison is the heart of calibration work. The standard or reference thermometer's accuracy and traceability are the most important criteria in calibration quality. The first step in achieving quality is finding the right balance between your accuracy needs, durability requirements, budget and thermometer type.

Standards Thermometer Readouts

Most labs have at least one SPRT calibrated by a national lab. This SPRT has been calibrated against a range of fixed point cells as primary standards. High quality readouts are used with this SPRT for maximum accuracy in the lab. Resistance bridges provide the most accurate readout available but cost between $20,000 and $50,000. This is cost effective only if 1 ppm accuracies are necessary.

If accuracies of 4 ppm or more are satisfactory, then much less costly alternatives to bridges are available. Hart's Super-Thermometer is one example of an instrument costing less than $12,000 reading to 4 ppm and having automation software built-in for ease of use.

Working standards are available in the Hart 1502, 1506 and 5501 thermometers. These instruments read 100 ohm PRTs and display temperature directly.

Smart Probes combine the PRT probe and the readout electronics in one compact, completely portable system. These probes connect directly to an RS-232 port.

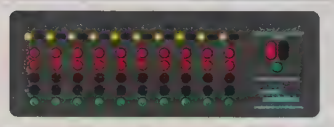
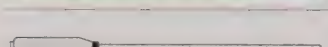
Other Probes

Hart offers a complete line of reference probes such as PRTs, thermistors and type S thermocouples. All of these units are affordable working standards. And Hart ships each unit it sells with a certificate of traceability.

Industrial reference thermometers are also available for field instruments, inexpensive lab use and in combination with a variety of handheld readouts. Glass thermometers are on page 53 and a variety of thermometer readouts are also available.

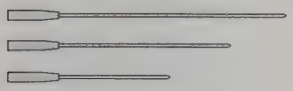
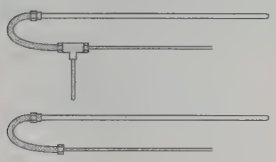
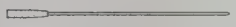
Nobody in the temperature calibration business has a wider selection of instruments and no one in the industry knows how to use them better than Hart. Call us and discuss your applications, objectives and budget. We'll help you meet your goals.

Standards Thermometer Readouts

	Model	Range	Accuracy	Features	Price	Page
	1502 "Tweener" Thermometer	–183°C to 850°C†	±0.05°C†	Resolution: 0.001°C. 100Ω Pt RTD sensors, ITS-90, IEE751, RS-232, IEEE option.	$1,195	32
	1506 Metrology Thermometer	–180°C to 650°C†	±0.005°C†	Resolution: 0.0001°C. 100Ω Pt RTD, 25Ω SPRT, thermistor sensors, RS-232, IEEE option, 2 channels.	3,495	34
	1575 Super-Thermometer	0 to 500KΩ†	±0.001°C 4ppm†	Resolution: 0.0001°C, 0.00001°C with thermistors. All PRTs, thermistors, SPRTs, HTPRT sensors. RS-232, IEEE, Graphic LED display, 2 channels.	11,995	36
	2575 Mighty-Mux Multiplexer			Adds 10 channels to 1575	3,995	43
	5690L Smart Probe	–183°C to 500°C	±0.01°C	Integrated probe and electronics. Outputs digital reading directly to PC via multiplexable RS-232.	2,950	44
	5691L Smart Probe	–183°C to 420°C	±0.025°C		2,150	
	5693L Smart Probe	–183°C to 600°C	±0.05°C		2,550	
	5501 Axonix A1011 Thermometer	–200°C to 850°C†	±0.01°C†	Configure up to 4 channels. 25Ω, 100Ω, and other PRTs. RS-232 and IEEE options.	$2,275 to $5,010	46

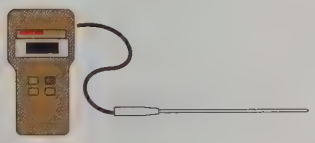
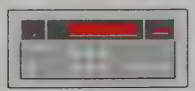
†Actual range and accuracy are dependent upon probes and range of use.

Reference Probes

	Model	Range	Length x OD	Accuracy†	Price	Page
	Secondary Reference RTD					
	5614	–200°C to 500°C	12" x 0.25"	@0°C ±0.007°C @200°C ±0.024°C	$650	47
	5612	–200°C to 420°C	9" x 0.187"		650	
	5613	–200°C to 300°C	6" x 0.187"		650	
	Type S Thermocouple Standard					
	5630	0°C to 1450°C	17.7" x 0.28"	±1°C	1,795	48
	5637		25.5" x 0.28"		1,895	
	5638 No Cold Junction		17.7" x 0.28"		1,595	
	5610 Thermistor Probe	–10°C to 110°C	9" x 0.125"	±0.01°C	650	50
	5611 Bare Thermistor Probe	–10°C to 110°C	<0.1" dia.	±0.01°C	350	51
	Thermistor Standards					
	5640	0°C to 60°C	9" x 0.25"	±0.0015°C	950	52
	5641	0°C to 60°C	4.5" x 0.125"	±0.001°C	1,560	
	5642	0°C to 60°C	9" x 0.125"	±0.001°C	1,560	
	5643	0°C to 100°C	4.5" x 0.125"	±0.0025°C	1,395	
	5644	0°C to 100°C	9" x 0.125"	±0.0025°C	$1,395	

†Accuracy of the probe's calibration.

Industrial Reference Thermometers

	Model	Range	Accuracy†	Features	Price	Page
	Glass Thermometers	–38°C to 405°C –36°F to 761°F	0.1°C Divisions 0.2°F Divisions	ASTM type Sets available	$150 & up	53
	5504 Thermistor Meter	–20°C to 130°C –4°F to 266°F	±0.015°C ±0.03°F (meter only)	YSI 400 Series Thermistors C/F Switch 0.01°C Resolution	515 (meter) 150 (probe)	56
	5512 Series Handheld RTD System	–100°C to 500°C –148°F to 932°F	±0.3°C ±0.5°F (System)	Attached Probe System Calibration Included Different Probe Options 0.1°/1° Resolution Analog Output	445	55
	5515 Handheld Thermocouple Reference	0°C to 1767°C 32°F to 3213°F	±0.25% of Rdg. ±1°C (meter only)	Reads Type S Probes System Certification Option C/F Switch Also Reads Types K and R 1° Resolution	225 (meter) 390 (probe)	54
	5505 Azonix Scanner Plus	Thermocouples J,K,S,R,T,I,N,B,E RTD –200°C to 850°C	±0.3°C ±0.01°C	Read sensors under calibration Configure for up to 40 Channels RS-232 Option	$2,570 and up	57

†Dependent on range and probe.

"TWEENER" THERMOMETER

"Tweener" Thermometer	Model 1502
Newest thermometer electronics	
Medium level accuracy	
Front panel programmable	
RS-232 included, software available	

The Hart Model 1502 "Tweener" Thermometer gives what you need at a price you can afford. And because it does, it's now one of the best selling thermometers in the industry. When you need more accuracy than a hand-held thermometer produces and less than a metrology thermometer, you need a "Tweener".

The Hart "Tweener" offers accuracy of ±0.05°C and a resolution of 0.01 degrees (0.001 degrees below 100°C) for only $1,195.

In addition, the 1502 thermometer is programmable to match any probe's constants for maximum linearity and accuracy. All probe constants and coefficients are programmed through simple front panel keystrokes. Temperature is displayed in °C, °F, K or resistance in ohms.

The 1502 accurately measures the resistance of the probe and then converts the resistance to a temperature figure using its built-in algorithms.

For convenience, the 1502 is already set up to read the common industrial grade IEC751 or "385" ALPHA RTD without any programming. Enter the actual R_0 and ALPHA of the individual probe for increased accuracy. For maximum accuracy, use the IPTS-68 or ITS-90 formulas. If your probe calibration includes IPTS-68 values for R_0, ALPHA, DELTA, A_4 and C_4, enter these and the "Tweener" mathematically converts readings to ITS-90 equivalents.

ITS-90 formulas reside in the "Tweener's" firmware. If your probe has been calibrated for any of the subranges of the ITS-90, you simply enter the constants directly in to the "Tweener" for complete compliance with the strictest requirements for ITS-90 measurements.

The 1502's temperature scale is selectable between IPTS-68 and ITS-90. In the ITS-90 mode, all readings are automatically corrected to ITS-90 readings, so manual computations are unnecessary.

Each thermometer comes complete with an RS-232 interface at no additional cost. You can automate temperature data collection, calibrations or process control functions. Use the Hart "Tweener" with dry-well calibrators to improve field calibration accuracy. It is only 6.5 x 2.7 x 8.8 inches, so it's lightweight and easy to carry. The entire 1502 is built using the newest and best in microelectronics. It's a very durable instrument for field or laboratory work.

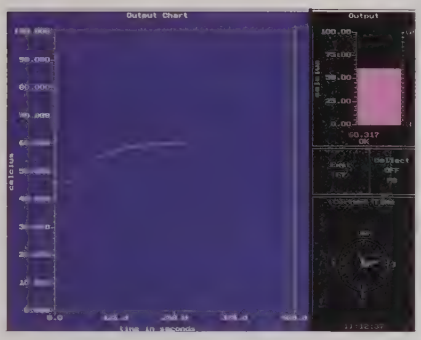
The 1502 is calibrated digitally using the front panel buttons. The enclosure does not have to be opened to reach manual trimpots found in other units. Standard resistors are simply connected to the Model 1502 and the readout adjusted. This calibration protocol further reduces the cost of the 1502. It makes it an ideal instrument for field use or satellite calibration labs. Certify its accuracy and performance quickly with a minimum of hassle and expense.

Hart offers complete system calibrations for the 1502 and any of the probes listed. This reduces measurement error and provides a traceable certificate for the combination of the "Tweener" and probe. Accuracy and prices are shown on the opposite page.

Printer

Add the optional mini-printer to your "Tweener" purchase for conven-

Hart's popular "Tweener" thermometer with the optional mini-printer for portable data logging applications.



The optional software allows temperature displays on your PC screen.

ient hard copy output of your measurements. Plug it into the RS-232 port on the back of the 1502 and you've got a printing data logger. Set a print interval in increments of one second through the front panel of the 1502. The printout gives the temperature with full resolution as displayed on the 1502 with an indicator for Celsius, Fahrenheit, Kelvin or ohms.

The 20-column thermal printer uses rechargeable NiCad batteries and comes complete with an AC adapter/charger. Each printer comes with a roll of paper and a serial cable so you can log precision temperature data soon after you receive your order.

Software

In addition, the 1502 is available with a small, easy-to-use RS-232 communication and data acquisition software package. It displays temperature in several formats on your PC's screen: bar graph, strip chart or digital display. It also has high and low temperature alarms.

This is another excellent instrument from Hart Scientific, a leader in temperature calibration instruments both in primary and secondary standards.

Specifications

Range: –183°C to 850°C

Accuracy: ±0.05°C (meter only)

Repeatability: ±0.02°C

Display: LED °C, °F, K, or ohms

Sample Rate: 1 per sec.

Sensor Type: 100Ω Pt RTD, any ALPHA

Probe Programming: Enter R_0 and ALPHA; R_0, ALPHA, DELTA, A_4 and C_4; ITS-90 ranges 4, 7–11

Temperature Scale: Select readout according to IPTS-68 or ITS-90

Filter: Programmable digital filter

RS-232 Interface: Included, 300–2400 baud

Battery Backup: Saves calibration and probe constants during power-off

Operating Range: 0°C to 50°C

Power: 110/220 VAC, 50–60 Hz

Probe Connection: 5-pin DIN plugs, 1 included with meter, spares available

Calibration Certificate: Included, traceable to NIST with actual calibration data provided

Size: 2.7" H x 6.5" W x 8.8" D (69 mm x 165 mm x 224 mm)

Weight: 3.25 lbs (1.47 kg)

Ordering Information:

1502 Thermometer	**$1,195**
2506 IEEE Option	**295**
2505 Spare Connector	**15**
2509 Data Acquisition Software	**50**
2507 Mini-Printer	**395**
2508 Serial Cable Kit	**29**
5614 RTD Probe 0.250" dia x 12" long (6.35 mm x 305 mm)	**650**
5613 RTD Probe 0.187" dia x 6" long (4.74 mm x 153 mm)	**650**
5612 RTD Probe 0.187" dia x 9" long (4.74 mm x 229 mm)	**650**

Accuracy and Calibration Options 1502 and 5614 (or 5612, 5613)

Option	Range	System Accuracy	Order No.	Price
No system calibration. Meter and probe calibrated individually.	–183°C to 420°C	±0.083°C	N/A	**N/A**
2-Point System Calibration	0°C to 100°C	±0.035°C	1830	**$160**
5-Point System Calibration	–183°C to 420°C	±0.06°C	1831	**400**

METROLOGY THERMOMETER

Metrology Thermometer	Model 1506
Meter accuracy to ±0.005°C	
Certified traceable to NIST	
User programmable sensor curves and PC input constants	
Resolution to 0.0001°C	

For the demanding temperature measurement needed in standards lab work, few meters match the precision of the Hart Model 1506 Thermometer. It is microprocessor controlled and PC programmable for specific temperature probes. The Model 1506 features 0.0001°C resolution and ±0.005°C accuracy.

Dual input channels for two probe work, contiguous sample averaging, minimum and maximum temperature recall and analog output are all standard features. Front panel buttons allow the user to select five digital readout scales: °C, °F, K, R or ohms, thus eliminating the need for conversion tables. Front panel switching also lets the user select probe 1 or probe 2, or choose probe 1 minus probe 2 for differential thermometry applications. Two calibration baths can be monitored simultaneously without having to move temperature probes.

The analog output range is 0 to 1.020 V with front panel selection of scaling factors for zoom-in resolution. With a sample rate of one reading per second, the Model 1506 provides resolution of 0.001 degrees on all scales, and at one sample every five seconds, the resolution increases to 0.0001 degrees. Two or three digit accuracy is guaranteed, and additional digits are displayed for sensitive research work.

In the 0°C to 100°C range, you can combine the 1506 with a high accuracy thermistor standards probe for higher resolution, smaller sensor size and greater mechanical shock resistance than RTDs and less expense than SPRTs. For about half the price of an SPRT system you can have the same performance.

The Hart Model 1506 Thermometer achieves its excellent precision by using AC circuitry to provide noise-free thermal measurements. EMF rejection electronics of this type are generally reserved for the very expensive thermometers found in metrology labs.

Specifications — Model 1506

Range: –180°C to 650°C

Sensors: Platinum RTD 25 to 1000 ohms at 0°C; Thermistor 100 to 100K ohms at 25°C

Accuracy:
- **Linearization:** ±0.005°C (±0.02°C w/25Ω)
- **Typical System Error with:**
  - 5614 PRT: ±0.03°C
  - 5610 Thermistor: ±0.015°C
  - 5642 Thermistor: ±0.006°C

Resolution: 0.001 all scales at 1 second sample interval. 0.0001 all scales at five second sample interval. 0.00001 all scales at 100 second sample interval. Significance of the last digit is dependent on the stability and sensitivity of the sensor.

Repeatability: ±0.005°C

Temp Coefficient: ±0.001°C/°C

Selectable Scales: °C, °F, K, R, or ohms

Inputs: 2 sensors, 4-wire plus shield

Connector: Binding posts

Delta T: Probe 1 minus Probe 2

Memory: Minimum and maximum temperature recall

Analog Output: 0 to 1.020 VDC, user scaling and centering, useful for stability or deviation monitoring

Equation: Fourth order polynomial. IPTS-68, ITS-90 and Callendar-Van Dusen conversions available

Calibration: Shipped with certificate of traceability to NIST

Self-Heating Effect: None

Measurement Current: 1 mA nominal

Communications: RS-232 included, IEEE-488 is optional

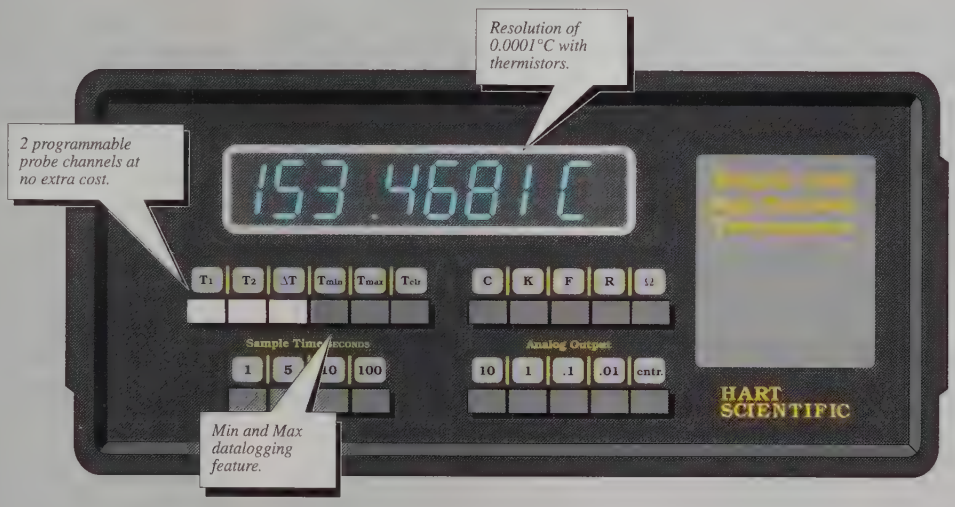
Power: 115 VAC or 230 VAC, 50–60 Hz

Size: 6" H x 11" W x 15" D (152 mm x 279 mm x 381 mm)

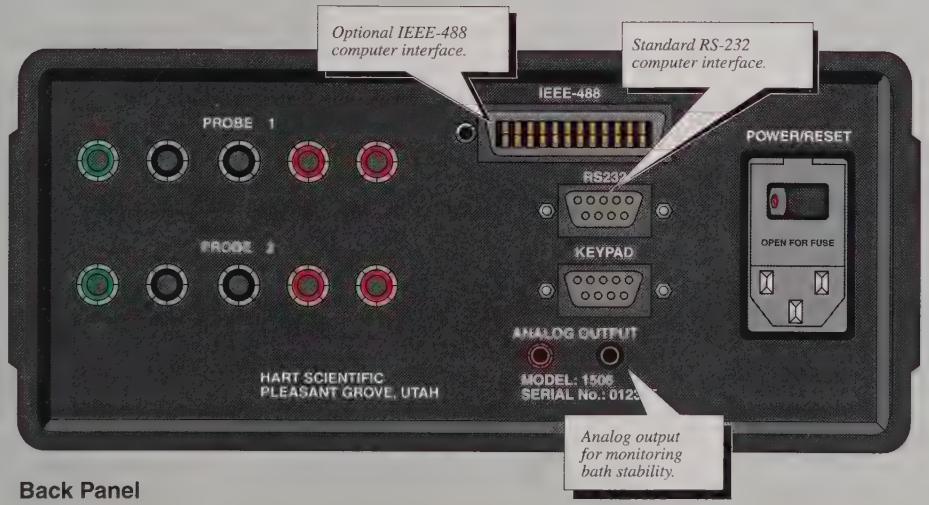
Weight: 10 lbs (4.5 kg)

Ordering Information:

1506 Thermometer	**$3,495**
2501 IEEE-488 Interface	**500**



Front Panel



Back Panel

SUPER-THERMOMETER

Super-Thermometer	Model 1575
Typical accuracy of ±0.001°C	
0.25 ohm through 100 ohm SPRTs plus thermistors	
Easier to use and less expensive than resistance bridges	
Store up to 16 probe linearizations for instant setup	

If you need resistance bridge accuracy, but you want an easy to use instrument at a modest price, the Hart 1575 Super-Thermometer with its ±0.001°C accuracy will make you very happy.

Why pay for a bridge or settle for a Digital Multimeter when the Super-Thermometer is the perfect alternative?

The Model 1575 is well suited for SPRT calibrations. It reads temperature directly, features automated data collection and automatically calculates constants for ITS-90. And there's much more.

Costs

Capital equipment justification is tough work these days. So if you're considering a resistance bridge, keep these four things in mind.

Resistance bridges are the most expensive piece of lab equipment you can buy. Most sell for $30,000 to $50,000. The resistance bridge market is very small, and there's hardly any competition. There's nothing to control the price except your willingness to pay!

Resistance bridges are difficult to use. Their learning curve is long and complex, which means you'll spend plenty of time learning to master one. Time spent learning or teaching others costs you money.

Getting an accurate temperature measurement with a bridge can be time consuming and clumsy when compared to measurements done with Hart's Super-Thermometer. Look at all the automated metrology functions you get on-board the 1575. You won't find most of these on more expensive bridges.

And finally, consider the issues of repair and maintenance. You can't afford to have your primary thermometer readout gone for weeks at a time. Read about our Service-or-We-Pay guarantee in the back of this catalog. If your 1575 needs service, you'll get it fast.

Alternatives

The Model 1575 Super-Thermometer solves all of these problems plus more. Temperature is read directly on the display in your choice of scales. There are no manual resistance-to-temperature conversions. Resistance is converted to temperature for you using the ITS-90 algorithm in any one of the instrument's ranges. Up to 16 independent sets of probe characterizations can be stored in the 1575's memory. Switch SPRTs and simply call up its reference identification number. Forget the extensive time-consuming setup required by conventional bridges.

The 1575's ease of use means less cost and more productivity. It's accuracy at an affordable price.

Accuracy

The typical benchtop thermometer has an error level 5 to 10 times greater than the Super-Thermometer. With common 25 or 100 ohm SPRTs, the 1575 achieves ±0.002°C accuracy and ±0.001°C accuracy with an external standard resistor.

ITS-90 specifies the use of 2.5 ohm and 0.25 ohm SPRTs as high temperature standards up to the Silver Point (962°C). This very small resistance is difficult to measure and is commonly done only with resistance bridges. The Super-Thermometer addresses ITS-90 problems directly and is absolutely the most cost-effective solution available.

In addition, resolution with a 25 ohm SPRT is 0.0001°C. Comparison calibrations, or calibrations against primary standard fixed points, are easily performed. The 1575 has two channels for handling two probes at once. Display and record actual temperatures or choose to read the difference between the two probes directly from the screen.

Each 1575 Super-Thermometer has its own on-board resistors. Each resistor is a low thermal coefficient, four-terminal resistor for each of the resistance ranges of the thermometer: 0.25 ohms, 2.5 ohms, 25 ohms, 100 ohms and thermistor ranges. Resistors are housed in an internal temperature controlled oven. It just doesn't get any better than this!

Probe Characterization

Resistance is converted to temperature using your choice of ITS-90, IPTS-68 or Callendar-Van Dusen equations. ITS-90 requires no conversions, just enter your constants directly. For IPTS-68 enter R_0, ALPHA, DELTA, A_4, and C_4. Temperature can be converted from IPTS-68 to ITS-90 automatically at your request.

Thermistor probes are characterized by coefficients of a logarithmic polynomial. Save money and use inexpensive, rugged thermistor standards for ±0.002°C accuracy in the low temperature regions.

Other Features

Measurements can be displayed as temperature in degrees C, K, or F and as resistance in ohms or a ratio of probe resistance to reference resistance. The current source is controllable between 0.001 mA and 15 mA with a resolution of 0.2%. Integration time and digital filtering are programmable to optimize resolution, stability and response.

Data logging and memory functions store measurements, and the thermometer has its own 3.5" disc drive for archiving data. The display is a backlit

LCD with graphical capabilities for visual display of information. It has an RS-232 port, an IEEE-488 port and a printer port, all standard.

The Super-Thermometer is based on DC electronics design thus eliminating the problems with national lab certification for AC bridges and the removal of induced interference from AC heated fixed point furnaces.

The 1575 is easy to use, accurate and absolutely priced right. Order yours now and forget resistance bridge hassles. What other instrument does all this?

Super-Thermometer *vs.* Digital Multimeter

If you're considering an 8½ digit multimeter for temperature calibrations and you want to do better than ±0.005°C accuracy in the resistance measurement, take a hard look at the 1575 Super-Thermometer. If you buy that DMM, you'll have to provide a separate high-stability current source, make EMF offsets, worry about a scheme to switch between forward and reverse current during the measurement, devise a switch to get a second channel for an external standard resistor and do all the resistance to temperature conversions with tedious, error prone manual calculations. With Hart's Super-Thermometer, all the variables are already under control. Add up the expense and risk of building a system from separate components and you'll agree the Super-Thermometer is the best value.

Watch Deal

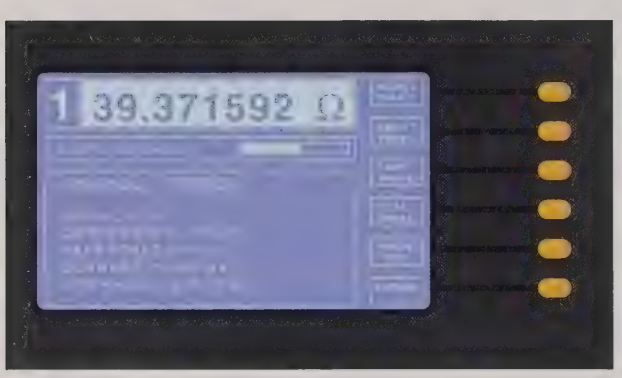
We bought some "Limited Edition Commemorative" Superman watches to celebrate the success of our Super-Thermometer. Their design is based on the original 1939 timepiece. We want to give 50 of them to you, so with the next 50 Super-Thermometer orders we'll send you a free watch. Wear it yourself or give it to your kids. In fact, buy each one of your kids a Super-Thermometer and get them all watches.

(Okay, that's part of the story. Read on to find out the rest.)

Customize Your Display

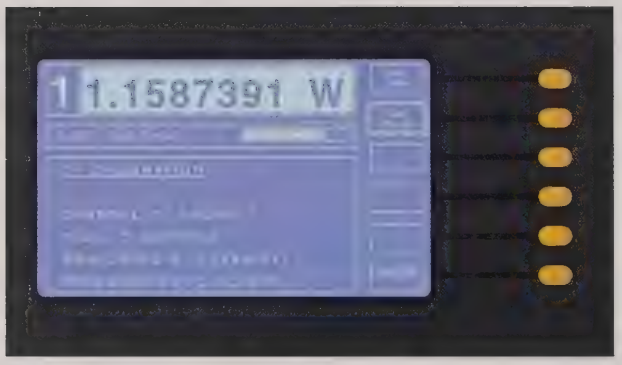
The graphic screen on the 1575 is easily modified to include information that fits your application or preferences. Under the display menu you select up to five lines of on-screen information from 19 different options including:

HISTORY	Value of any of the last one hundred samples
MEMORY	Any value you have stored in memory
T-HISTORY	Current value minus the last value
T-MEMORY	Current value minus the value in memory
T(1)-T(2)	Channel one minus channel two
T(2)-T(1)	Channel two minus channel one
MAXIMUM	Peak reading since last reset
MINIMUM	Lowest value since last reset
SPREAD	Maximum difference between readings
AVERAGE	Computes average of previous samples
STD DEV	Computes standard deviation of previous samples



Probe Setup

Each probe's information is identified by its unique serial number for assignment to a specific channel. You select the desired resistance to temperature conversion formula, set the probe constants, select the reference resistor, and the drive current. A total of 16 probe setups are stored in internal memory. An unlimited number can be stored to disk and selected when needed. After a probe's information is entered the first time, the 1575 is immediately set to match that probe by simply selecting the probe's serial number.



Automatic Calculation of Constants

The 1575 automatically calculates the required constants for the ITS-90 temperature conversion. Connect your uncalibrated standards probe to the 1575, measure the resistance at the fixed points or against a calibrated standard, and the 1575 stores the resistance readings and automatically derives the correct constants. You don't need a calculator and a pad of paper. The 1575 enters the constants directly to the probe setup, saving you time and preventing error in the manual entry of constants.

The Triple Point of Water

You can use the Triple Point of Water (TPW) Cell in conjunction with your 1575 and SPRT to achieve minimum measurement uncertainty. Take a reading in the TPW Cell just prior to each new measurement. The 1575 stores the current Triple Point of Water resistance [R(273.16K)] value and references it during the conversion from resistance to temperature. This eliminates two sources of measurement error. The drift of R(273.16K) in the SPRT is removed and the error of the on-board reference resistors is canceled. For convenience and maximum precision, you can even enter the immersion depth of your SPRT in the Water Triple Point Cell to correct for hydrostatic head.

Specifications Model 1575

Accuracy at 0°C:

	Int. Ref.	Ext. Ref.
100Ω	±0.002°C	±0.001°C
25Ω	±0.002°C	±0.001°C
2.5Ω	±0.01°C	±0.005°C
0.25Ω	±0.02°C	±0.01°C
Thermistor		±0.001°C

Resolution:

100Ω PRT	0.0001°C
25Ω PRT	0.0001°C
2.5Ω PRT	0.001°C
0.25Ω PRT	0.01°C
Thermistor	0.00001°C

Resistance Range: 0 to 500KΩ

Internal Reference Resistors: 1Ω, 10Ω, 100Ω, 10KΩ

Minimum Sample Rate: 2 seconds

Current Source: Program the current driving the resistances to any value between 0.001 and 15 mA

Analog Output: –5V to +5V

Isolation: To 200 V from earth ground.

Scale Units: Display measurements as temperatures in degrees C, K, F, or W(T_{90}), as resistance in ohms or as a ratio of probe resistance to reference resistance.

Sampling and Filtering: Program integration time and digital filtering to optimize resolution, stability and response.

Data Logging: A variety of data logging and memory functions are available for storing measurements for later recall, comparison, transmission or computing. A real-time internal clock is used to time stamp measurements or time events.

Display: Large high contrast backlit LCD graphics display shows a variety of data: currents and previous measurements, measurement statistics, probe selections, status and operating parameters and menu choices.

3.5" Floppy Drive: A floppy drive for storing measurement data, probe parameters, instrument configuration parameters and calibration parameters is included.

Communications: RS-232 serial interface, IEEE-488 parallel interface, Centronics parallel interface

Power: 115 VAC or 230 VAC, 50/60 Hz

Chassis: Benchtop enclosure is standard. Optional 19" rack mount is available.

Size: 20.3" W x 12.6" D x 7" H (515 mm x 320 mm x 178 mm)

Weight: 35 lbs (16 kg)

Ordering Information:

1575 Super-Thermometer	**$11,995**
9307 Case	**450**

New Graphing Feature

We've added a new feature to the Model 1575 Super-Thermometer that's not listed above. Now there is real-time, on-scale graphing for monitoring Fluid Bath stabilization or realizing Metal Fixed Point Plateaus. Simply monitor the graph for stability on one or multiple channels and take your readings in Resistance, Temperature, or the Ratio to the Triple Point of Water. The 3.5" disc drive stores all of the readings in an ASCII format for spreadsheet or graphing use. Graphing resolution limits are manually entered. Maximum resolution is automatically set as the readings stabilize over time. Temperature measurement labs save time by not monitoring or taking data every few seconds.

MODEL 1575 SUPER-THERMOMETER: THEORY OF OPERATION

The Model 1575 Super-Thermometer delivers high accuracy readings from standard platinum resistance thermometers (SPRTs). The 1575 makes precision resistance ratio measurements to determine temperature with an uncertainty of ±0.002°C or less. This technical note explains the instrument's measurement technique, the functions of each circuit block, and the sources of error and their solutions in the 1575 design.

Measurement Technique

The 1575 thermometer uses a voltage comparison method for measuring resistance ratios. This process is explained below. The simplified schematic shows the basic components.

The reference resistor and SPRT are connected in series. The source current flows through both. A resistance ratio measurement is made by sampling the voltage on each in turn, through the relay switch, and then dividing the voltages. The voltage on each resistor is measured with the current in the forward direction and then in reverse so that offsets can be eliminated. Thus, one ratio measurement requires four voltage samples as follows:

1. Thermometer, forward current–V_{tp}
2. Thermometer, reverse current–V_{tn}
3. Reference, forward current–V_{rp}
4. Reference, reverse current–V_{rn}

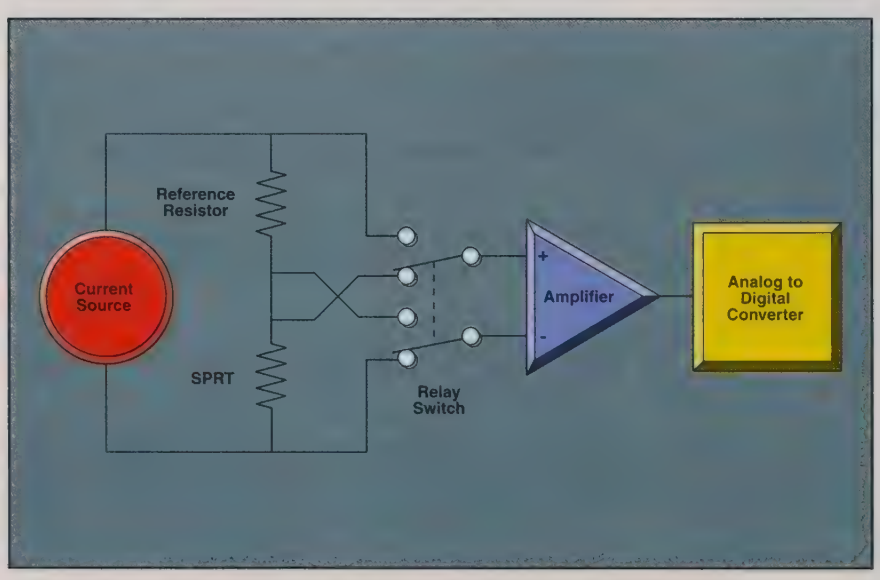
The samples are then subtracted and divided to produce a ratio of thermometer to reference resistance.

$$r = \frac{V_{tp} - V_{tn}}{V_{rp} - V_{rn}} = \frac{R_t}{R_r}$$

With this method, accurate ratio measurements are obtained regardless of the effects of source current imprecision, voltage offsets, and gain inaccuracies, as long as they do not vary appreciably during the period of measurement.

Each voltage sample requires .5 seconds, .15s to switch the current and relay and allow time for the voltage to settle, and .35s for the analog to digital converter (ADC) to convert the voltage and for the central processing unit (CPU) to read it. The entire ratio measurement is accomplished in two seconds.

Once the resistance ratio is obtained, the internal CPU can use digital filtering to smooth the data and convert it to resistance or temperature.



The CPU converts resistance to temperature according to the definition of the International Temperature Scale of 1990 (ITS-90). Any of the ITS-90 platinum resistance thermometer subranges can be used. The CPU uses the calibration coefficients unique to the SPRT to calculate temperature. These coefficients are stored in the 1575 in non-volatile memory. The 1575 can store each set of coefficients for all subranges. These and other user selected parameters such as the reference resistor and current are stored in memory as a complete probe configuration for the particular SPRT. The 1575 allows up to 16 different probe configurations to be stored in memory.

In addition to ITS-90, the 1575 can also calculate temperature according to IPTS-68, Callendar-Van Dusen equations, or a user specified polynomial equation. For thermistor probes, temperature can be calculated using a logarithmic polynomial equation. Coefficients for any selected conversion algorithm can be stored in the probe configuration.

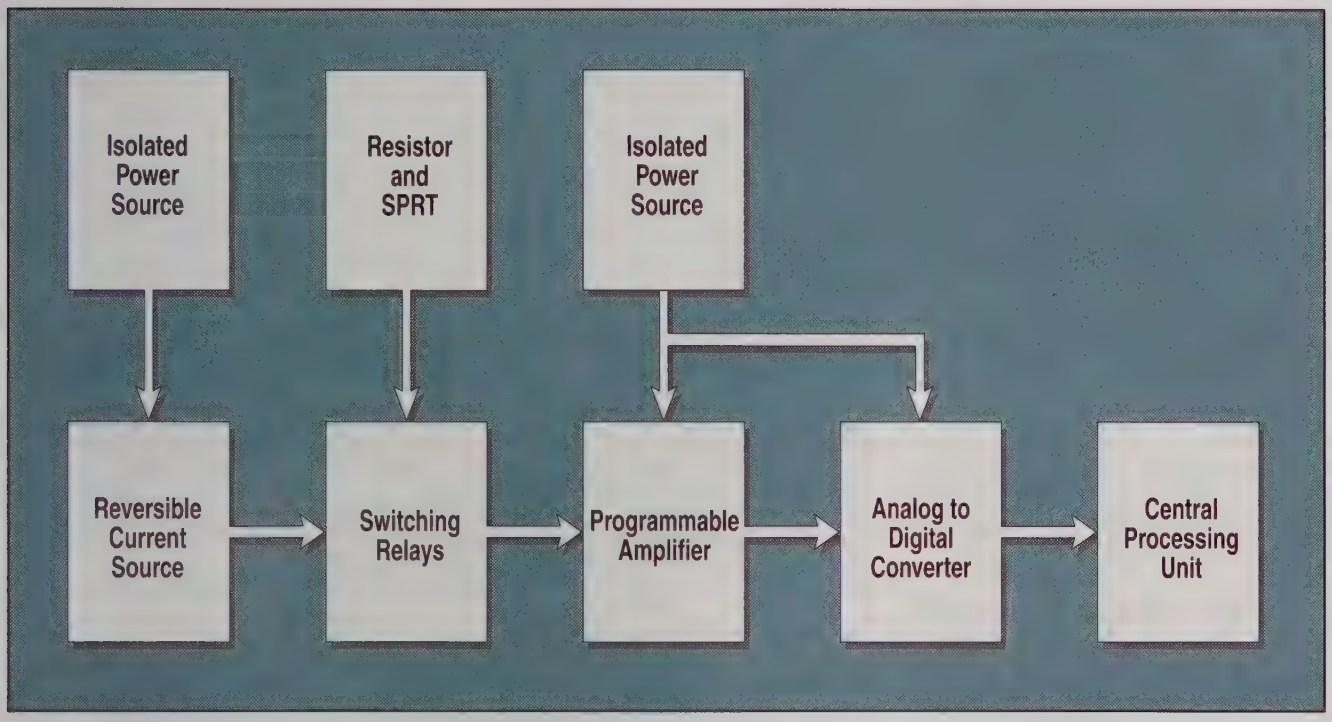
The 1575 thermometer can display temperature in units of degrees Celsius (°C), degrees Fahrenheit (°F), or Kelvin (K). Measurements can also be displayed as resistance in ohms (Ω), as a resistance ratio relative to the reference resistance, or as a resistance ratio relative to the Water Triple-Point Resistance of the SPRT [$W(T_{90})$].

Measurement Circuitry

The primary function of the 1575 thermometer is to make highly accurate resistance ratio measurements to determine temperature. A block diagram of the measurement system is shown below. A description of each of the main components follows.

Power Source

The measurement circuitry derives power from two isolating DC-DC converters. The current source operates from a separate power source to insure



isolation from the amplifier and ADC. Good isolation is necessary to prevent any ground or leakage currents from passing through the resistor being sampled causing errors in the measurement. The entire measurement system is isolated from earth ground so that ground currents cannot flow through the external resistors or SPRTs.

Current Source

The current source provides a highly stable constant DC current for the resistance thermometer and reference resistor. The current source is programmable over a wide range of values to accommodate a wide variety of resistance thermometers. The high resolution allows the current to be increased in 1.414 ratios for sensor self-heating measurement and error correction. The current can also be reversed so that thermoelectric errors and DC offsets can be subtracted out.

Resistors

The 1575 can measure resistance ratios between an SPRT and a user selected external resistance standard or an internal standard. There are four internal standards—1Ω, 10Ω, 100Ω, and 10kΩ for use with a variety of resistance thermometers. The internal standards are highly stable, hermetically sealed, low temperature coefficient of resistance (TCR) 4-lead metal film resistors. The resistors are placed in a small temperature-controlled oven to further isolate the resistances from ambient temperature variations.

Relays

The relays are used to switch between the two input channels, between the various internal and external standards, and also to connect the amplifier to either the SPRT or reference resistor. The highest quality reed relays available are used. They have low contact resistance, low thermal EMF, high reliability, and long lifetime.

Amplifier

The amplifier increases the low voltage measured on the resistors to a level appropriate for the ADC input to achieve optimum accuracy and resolution. The amplifier has an extremely low noise front end and low offset drift. The amplifier is programmable for a wide range of gain so that the ADC always receives the proper signal. The amplifier also filters out AC noise and interference.

Analog to Digital Converter (ADC)

The measurement voltages are converted to numbers the CPU can interpret with the analog-to-digital converter. The ADC is a dual-slope integrating type with a resolution of 24 bits. It can resolve 2μV over a 20V range which allows it to measure resistance ratios with great resolution. Being an integrating converter, it has excellent noise rejection and linearity. The sample period is less than .5 seconds. This enables samples to be taken quickly, reducing the effects of offset and gain drift. The ADC is bipolar; it can measure positive and negative voltages with equal accuracy. It is completely monotonic, even through 0V. This is necessary in order to accurately compensate for circuit offsets. The su-

perb linearity is also important for accurate ratio measurements.

Central Processing Unit (CPU)

The internal central processing unit (CPU) controls the entire measurement process, reads the sample values, and calculates the ratio, resistance, and temperature. All signal lines between the CPU and measurement circuitry are optically isolated to eliminate ground and leakage currents and conducted high-frequency interference.

Accuracy

To achieve supreme accuracy the design of the 1575 required careful consideration of all sources of error.

Offsets

DC offsets come from various sources: the current source, amplifier, ADC, and thermal EMFs in the circuit connections. The effects of DC offsets are canceled by mathematical subtraction.

Gains

Gain errors come from the current source, amplifier, and ADC. Since the samples are divided to obtain a ratio measurement, these errors are also canceled.

Nonlinearity

Some amount of nonlinearity is intrinsic to the amplifier and ADC. By nature of the measurement technique, first order nonlinearity is canceled out. Higher order components of the nonlinearity potentially could cause errors; however, the particular devices used for the amplifier and ADC have excellent linearity and this results in less than .2 ppm inaccuracy.

Drift

DC offsets and gains may cause errors in the measurement if they shift significantly during the period of a measurement. To reduce these drift effects, the measurement circuitry uses high quality, very stable, low TC components. The fast sample rate of the ADC also helps to reduce the effects of gain and offset drift.

Amplifier Input Impedance

The amplifier input impedance must be very high since it appears in parallel with the resistor being sampled. The extremely high input impedance of the amplifier used in the 1575 eliminates this problem.

Common Mode Error

Errors potentially could arise from inadequate common-mode rejection in the amplifier and ADC circuits. To avoid this, the circuits are isolated from each other by the use of DC-DC power converters and signal optocouplers. The common-mode voltage of the inputs to the amplifier and ADC can then be fixed at 0V eliminating the possibility of common-mode error.

Leakage

Leakage currents between the isolated circuit components and to ground could also cause errors since the currents would only flow through the resistor being sampled. The use of high quality, low leakage optocouplers and DC-DC converters is important.

Reactance

In many AC resistance bridges significant amounts of capacitance and inductance in the thermometer, reference resistor or connection wiring may produce errors in the measurement. The 1575 uses essentially a DC measurement scheme. Switching transients from circuit reactance are allowed to settle long before sampling commences. Thus, accurate measurements are obtained regardless of any reactance and either DC or AC/DC standard reference resistors can be used. When using probes or reference resistors with unusually high reactance, the sample period can be increased to allow for longer settling times.

EMI

The sensitive components of the system are isolated and shielded to reduce conducted and induced noise and interference.

Noise

Noise in the measurement comes from many sources—the current source, resistors, amplifier, and the ADC. Typically, noise will be the most significant limitation to measurement accuracy. To minimize noise at its source, the lowest-noise components available have been selected. Filtering is used throughout the measurement circuits to eliminate as much noise as possible. The CPU can use any of a wide variety of digital filtering techniques to further smooth the measurements.

Summary

That's not the whole theory of the Super-Thermometer's operation, but it's close enough. We've got a long list of happy customers—why don't you join them and buy one of these great instruments.

These are the five bridges we accepted out of the many we were offered on our Trade-a-Bridge for the Super-Thermometer Program. I wonder why all those labs wanted to trade their bridges?

MIGHTY-MUX MULTIPLEXER — Model 2575

Mighty-Mux Multiplexer	Model 2575
Gives the Super-Thermometer a total of 11 channels	
Automate the calibration of PRTs or thermistors	
Controlled by the Super-Thermometer or manually	
Low contact resistance and thermal EMFs	

As a complement to our new Super-Thermometer, Hart now has the Mighty-Mux, a ten channel multiplexer.

The Mighty-Mux plugs directly into the Super-Thermometer for a total of eleven channels. Automation of PRT and thermistor calibration is easy with the Model 2575. The Super-Thermometer reads the user selected channels or scans them automatically, saving the readings on a floppy disc or printing them out.

With the Mighty-Mux, you can operate several standards at once and read them from one instrument. This not only saves equipment costs, it makes collecting data efficient. Fixed-point or comparison calibrations are faster regardless of the type of probe you're working with. This instrument pays for itself in weeks.

The Model 2575 is controlled by the microprocessor in the Super-Thermometer, which means your computer only has to communicate with one instrument!

Probes are connected using easy-to-grip, gold-plated binding posts. The terminals are on the front panel for convenience, and amber LEDs light to indicate which channel is currently selected. Each channel is independently isolated. Low thermal EMF relays are hermetically sealed and magnetically shielded. Contact resistance is less than 0.1 ohm. The Mighty-Mux offers true 4-wire measurement with a floating guard, and it supports up to 50 milliamp drive currents. Measurement time per channel is 2 seconds.

The Mighty-Mux didn't get its name for nothing; it took us all day to think of it. Please don't forget the hyphen when ordering.

Specifications — Model 2575

Channels: 10

Connection: 4-wire plug, floating guard

Terminals: Gold-plated binding posts

Relays: Low thermal EMF, hermetically sealed, magnetically shielded

Contact Resistance: <0.1Ω

Isolation: 1 x 10^{12} between relay legs.

Channel Selection: Manual or auto.

Current Capability: 50 mA

Power: Via connection to 1575

Size: 20.3" W x 12.6" D x 7" H (515 mm x 320 mm x 178 mm)

Ordering Information:

2575 Mighty-Mux Multiplexer	**$3,995**

"SMART" PLATINUM RTD TEMPERATURE PROBES

"Smart" Platinum Temperature Probes — Models 5690 , 5691, and 5693
New Model 5693 extends range to 600°C
Eliminate costly readout and interface hardware
Read temperature directly on a laptop or desktop computer
Accuracy to ±0.01°C (NIST traceable)
Plugs into any RS-232 port

This year we've added a new 600°C model to our popular "Smart" Probe series. Designed and manufactured for Hart by XSYS Corporation of Sudbury, Massachusetts, the 5690 series probes provide direct digital output of temperature with no additional instrumentation.

This "Smart" Probe combination cuts system error in half, eliminates the annual calibration problems and costs of calibrating both a probe and a readout instrument, makes automation of calibration jobs simple and easy, makes ITS-90 conversion inexpensive and available now and gives you the best in a portable precision temperature measuring instrument without any sacrifice in accuracy.

System Error Cut in Half

Traditional precision temperature measurement is performed with a high quality probe, like an SPRT, connected to some type of readout device, such as a DVM or other instrument capable of reading the analog signal produced by the probe. Both the probe and the readout instrument must be calibrated periodically to compensate for their normal electronic error.

Unfortunately, even after separate rigorous calibration of both instruments, each one will still contain a degree of error. Connecting both the probe and readout instrument together produces a single system having a total system error equal to the sum of the errors found in each instrument.

Additional readout error is often introduced into temperature measurements during the process of converting the probe's analog signals into degrees of temperature. Manual computations, look-up tables and other conversion methods can add to the system error already present.

The Hart Series 5690 "Smart" Probes have inboard digital electronics. Because the electronics are integrated into the probe, the probe and readout device are calibrated as a single instrument. Analog to digital conversion is direct, requiring no manual interpolation or other off-instrument calculations.

Because the "Smart" Probe acts as only one instrument, sources of system error are cut in half.

How many other new temperature calibration instruments have you seen that actually improve the precision and accuracy of your temperature measurements and simultaneously reduce your equipment costs?

Reduced Operating Costs

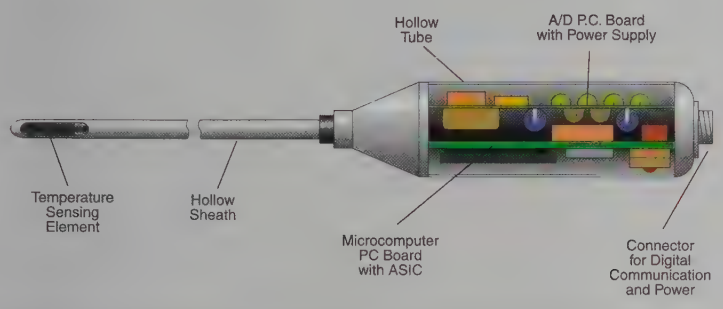
The Hart Series 5690 probes lower your operating costs in three distinctive ways.

Since each 5690 probe has its own fully-integrated digital circuitry, no readout instrument is required, thus reducing your thermometry equipment costs. You can use as many 5690s as the job requires (up to 99) without having to buy additional hardware, which often costs many times more than the probes.

With only one instrument to calibrate, your annual calibration maintenance costs are lower, and as a bonus, overall system error is reduced.

Multiple 5690 probes can be linked together in parallel and then connected to the RS-232 port on your computer for automated calibration or temperature measurements. All software is

Sectional View of the 5690 Series Probes


Hollow Tube
A/D P.C. Board with Power Supply
Temperature Sensing Element
Hollow Sheath
Microcomputer PC Board with ASIC
Connector for Digital Communication and Power

built-in, so any temperature monitoring job is automatable without additional software expense.

Each 5690 is usable up to 1000 feet from your PC and doesn't require an internally installed A/D board. These "smart" probes are controllable from any desktop, laptop or handheld computer that has an RS-232 port.

Fully Portable

Each 5690 probe is totally self-contained. Its software is stored in nonvolatile EEPROM memory. Calibration coefficients, filtering constants and the probe address all go with you when you need to take one of your 5690s out of the lab.

The probe is compatible with CRTs, VDUs or PCs that have an RS-232 port. Leave your desktop computer on your desk and use a field unit or bring along your favorite laptop.

Measure against any temperature scale; IPTS-48, IPTS-68 and ITS-90 are all contained in the 5690's memory. Changing scales takes only a couple of software commands and less than a minute.

Why carry multiple instruments on long trips when one will do the job better than two?

PC Software

Each smart probe is shipped complete with software for IBM PC compatible computers. Simply load the software on your computer and use the simple menu to select the probe function you need. Set all configuration parameters such as ITS-90 or IPTS-68, display measurement data, plot probe resistance or temperature, display data files, and use the calibration program to recalibrate the smart probe when it's time.

This ready-to-use software gives you data plots and precision measurements within minutes of unpacking your smart probe. The user's manual includes instructions and command sets for easy communication with the smart probe using other computers or terminals.

Specifications

(Typical at 25°C and nominal power supply)

Temperature Range:
5690L –183°C to 500°C
5691L –183°C to 420°C
5693L –183°C to 600°C

Accuracy Over Range:

5690L	±0.010°C
5691L	±0.025°C
5693L	±0.05°C

Resolution:

5690L	±0.001°C
5691L	0.001°C
5693L	0.001°C

Sensor Element: 4-wire platinum, 99.999% purity

Probe Construction: INCONEL

Dimensions: Overall length, 23.75"; Grip 5.75 x 1.25" (146 mm x 31.7 mm); Probe 18 x .25" (457 mm x 6.35 mm)

Calibration: Traceable to NIST

User Selectable Parameters: Temperature Scale: IPTS-48, IPTS-68, or ITS-90; Temperature Units: °C, °F, or Kelvin; Sensor Resistance in ohms

Power: Unregulated DC, 10 to 32 volts, 650 mW

User Programmable Functions (Stored in EEPROM): Probe Address from 01 to 99 and Baud Rate; Calibration Constants for Sensor and A/D; Probe ID Number and Calibration Date; Password; Digital Filtering Coefficients for Filter Band and Filter Magnitude

Communication: RS-232C Interface, 25-pin male connector (DB-25) ASCII format; Command/Response protocol with baud rates of 300, 600, 1200, 2400, or 9600

Environmental: Temperature Range: Operating –25°C to 75°C; Storage – 25°C to 85°C

Ordering Information:

5690L Probe, 0.01°C	**$2,950**
5691L Probe, 0.025°C	**2,150**
5693L Probe, 0.05°C, 600°C	**2,550**

Each probe includes software, 1 cable, 1 expander, 1 converter, 1 port adapter, 1 AC adapter,carrying case and NIST traceable certification.

5303-002 Cable, 25 feet	**22**
5303-003 Expander	**10**
5303-007 Converter	**80**
5303-008 Port Adapter 9-pin to 25-pin	**20**
5303-009 AC Adapter	**22**

PRECISION RTD THERMOMETER — Range: –200°C to 850°C

Precision RTD Thermometer	Model 5501
Up to 4 probe channels	
Individual input cards available	
Meter accuracy to ±0.01°C	
Programmable probe linearization	

For absolute value and unbeatable quality and performance in thermometry specs, you'll want the Hart Model 5501 Thermometer made by Azonix. The Model 5501 is a major advance in the manufacturing of digital thermometry for use with RTD probes.

The 5501 features a resolution of 0.001°C and an accuracy of 0.01°C over the full temperature range. It is capable of providing probe resistance to a resolution of one part per million. It computes advanced floating-point mathematical algorithms, displays data in all common engineering units and prints the data on demand.

Each unit supports individual signal conditioning modules which contain their own A/D converter, providing complete probe isolation for up to four probes. Spurious noise is no longer a problem.

The Model 5501 is available with a data logging printer for hard copy output of important measurement information such as the probe number, measurement value and the selected engineering units per probe.

Order the base unit 5501 and one input card for each probe you plan to use (up to four). You'll get a meter matched to your specific needs.

Specifications — Model 5501

Input: 1 to 4 channels, any mix of 25, 100, 200, 500 or 1000 ohm RTD, 3 or 4 wire connection

Linearization: Enter individual probe constants for IPTS-68, Callendar-Van Dusen equations, ITS-90 or select preprogrammed linearizations for any of the common alphas: 385 Pt.(DIN 43760), 3916 Pt, 392 Pt, or 390 Pt.

Resolution: 0.001 degrees

Accuracy: ±0.01°C

Scales: °C, °F, Kelvin, ohms

Delta T: Probe 1 minus Probe 2

Configuration: Isolated and floating point input for each channel

Input Range: –199.999°C to 850.000°C

Input Protection: ±130 volts

Isolation (CMV): 600V min., 1000V typical

Analog Output Option: Probe 1 only, 1 mV per 0.1°C, 0.05% typical

Communications Options: RS-232C or IEEE-488

Operating Temperature: 0°C to 60°C

Storage Temperature: –40°C to 85°C

Size: 4.5"H x 8"W x 13"D (114 mm x 203 mm x 330 mm)

Weight: Approx. 10 lbs (4.5 kg)

Ordering Information:

5501 Thermometer, No Inputs	**$1,495**
5302-010 25Ω, Input Card	**780**
5302-012 100Ω, Input Card	**780**
5302-014 200Ω, Input Card	**780**
5302-016 500Ω, Input Card	**780**
5302-018 1000Ω, Input Card	**780**
5302-001 Analog Output	**395**
5302-002 RS-232C Output	**395**
5302-003 IEEE-488 Output	**395**
5302-030 Printer	**795**

All cards 4-wire.
Consult Hart for 3-wire Input Cards.

SECONDARY REFERENCE TEMPERATURE STD Range: –200°C to 500°C

Secondary Reference Temp Std	Models 5614 , 5613, and 5612
Next best thing to a SPRT in accuracy	
Very modest price	
Rugged construction maintains stability	

The Hart Model 5614 is a 1/4 inch O.D. Resistance Temperature Detector (RTD) with an INCONEL 600 sheath 12 inches long. It is designed to be used as a transfer device from the highest laboratory standards to industrial on-site or second-tier laboratory locations.

This probe is an ideal match with high accuracy equipment using a one milliamp source current such as Hart Thermometers 1506 or 1502 and the Digital Multimeters on page 134.

The element is constructed of reference grade platinum wire (99.999% pure) for excellent stability. The wire is wound in a coil and placed in a mandrel where it is uniformly supported in a strain-free manner to virtually eliminate hysteresis. The electrical configuration is a 4-wire current potential type hookup to eliminate effects of leadwire resistance.

With its INCONEL sheath, these probes are more durable than quartz sheathed probes. And with accuracy of ±0.007°C at 0°C and ±0.033°C at 400°C is better than probes costing twice as much.

For those needing faster thermal response, or where diameter and immersion depth are problems, order the 5613 or 5612. These probes are excellent reference probes for comparison calibrations in a Hart dry-well.

For all of these probes, a computerized printout of sensor resistance is provided in 1°C increments. The 5614 and 5612 are calibrated from –183°C to 420°C. The 5613 is calibrated up to 300°C only, but is usable up to 500°C with reduced accuracy.

This high quality thermometer, fully calibrated, is less than 20% of the cost of an uncalibrated SPRT. It is more durable than an SPRT because of the INCONEL sheath and it uses the more convenient 100 ohm R_0 as compared to an SPRT's 25 ohm R_0.

Specifications

Resistance: Nominal 100 ohm ±0.1 ohm at 0°C

Temperature Coefficient: 0.003925 ohms/ohm/°C nominal

Temperature Range: –200°C to 500°C, transition and cable to 150°C max.

Resistance Stability: ±0.01°C at 0°C per year maximum, when used periodically to 400°C

Sheath Material: Inconel 600

Leads: Teflon insulated, silver-plated stranded copper, 22 AWG

Termination: Gold-plated spade lugs are standard. Specify 1502 connector if needed. Other options available.

Hysteresis: <0.01°C at 0°C using –183°C and 420°C as the end points

Immersion Effects: Reading will not vary more than 0.005°C when the probe immersion is varied between 4" and 10" in an ice bath (5614).

Size: 5612 - .187" dia. x 9" long
5613 - .187" dia. x 6" long
5614 - .25" dia. x 12" long

Calibration: Includes NIST traceable table with R *vs.* T values in 1°C increments from –183°C to 500°C. The 5614 and 5612 are calibrated to 420°C and the 5613 to 300°C. ITS-90 coefficients included.

Calibration Accuracy:

–183°C	±0.010°C
–38°C	±0.010°C
0°C	±0.007°C
200°C	±0.024°C
420°C	±0.033°C

Ordering Information:

5614 Secondary Standard PRT	**$650**
5613 Secondary Standard PRT	**650**
5612 Secondary Standard PRT	**650**
2601 Probe Carrying Case	**45**

Specify termination when ordering.

TYPE S THERMOCOUPLE STANDARD

Type S Thermocouple Standard	Models 5630, 5637 and 5638
High temperature standard per IPTS-68	
Includes cold junction probe	
Long-life construction	

The Hart Model 5630 is a complete Type S Thermocouple Standard for the range of 0°C to 1450°C. The premium grade measuring junction is enclosed in a special ceramic sheath.

The metal armor insulated thermocouple leads terminate in a cold junction probe that fits Hart's Model 9101 Ice Point Dry-Well or other ice baths. A flexible insulated 79-inch stranded copper cable attaches to the user's readout instrument. This combination ensures a complete assembly that meets the stringent calibration requirements necessary for high temperature work.

The special ceramic sheath isolates the precious metal thermocouple and protects the integrity of the probe's calibration.

The 17.5-inch long probe fits most calibration furnaces and fixed-point cells. If you need a longer probe, we offer an identical unit 25.5 inches long for deep furnaces and other applications.

The high performance materials and construction of the 5630 typically yield accuracies of ±1°C or better. With calibration by us, by you or by NIST, this is a solid value in a high quality probe.

The 5630 handles well and feels impressive. The insulated cable is flexible, and the armored section is the most pliable and easy to work with we've seen. Why bother with thermocouple standards that offer you only an exposed thermocouple with flimsy wire construction for a cold junction probe?

The Hart Model 5630 is a superb type S ceramic thermocouple.

Calibration Information

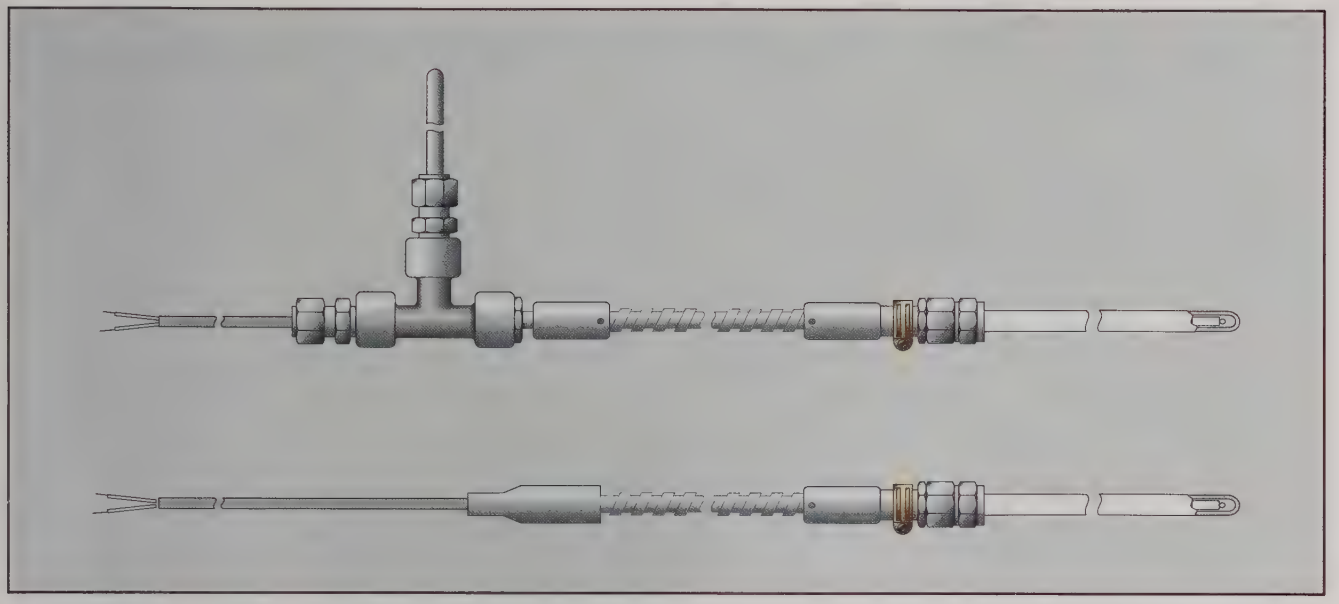
Each probe includes a comparison calibration of the specific thermocouple. The calibration is performed before putting the thermocouple into its sheath. The calibration is made against a NIST traceable or NIST certified thermocouple, with the calibration data on the measured points included with each instrument. A complete EMF *vs.* temperature table is also provided with a certificate of calibration.

These thermocouple assemblies qualify for calibration by NIST, if that's your preferred method of certification. The probe must be carefully disassembled according to the instructions in its manual and the bare wire thermocouple portion shipped directly to NIST. You can choose a comparison calibration or a fixed-point calibration according to your needs. Dean Ripple at NIST will coordinate this process with you. Contact him at (301) 975-4817.

No Cold Junction

Hart now has a new type S thermocouple without a cold junction for customers who want to provide their own cold junction or take advantage of electronic cold junction compensation.

The Model 5638 is made with the same high quality assembly as our 5630 and 5637 models. The armored cable provides protection to the thermocouple wires when working with high temperature furnaces. Its accuracy, use and calibration options are the same as found on the Models 5630 and 5637 above.



Construction of Type S Thermocouples with and without Cold Junction.

Specifications

Range: 0°C to 1450°C

Emf *vs.* Temperature: IEA 584

Type: Platinum-10% Rhodium ***vs.*** Platinum

Dim. Hot Junction:
5630: .28" dia. x 17.7" L (7.11 mm x 450 mm)
5637: .28" dia. x 25.5" L (7.11 mm x 648 mm)
5638: .28" dia. x 17.7" L (7.11 mm x 450 mm), 99.7% recrystallized alumina sheath

Dim. Cold Junction: 7.87" L x 0.236" dia. (200 mm x 6 mm), S.S. sheath

Calibration Uncertainty:
0°C to 1100°C ±1°C
1100°C to 1450°C ±2.5°C

Copper/Copper Wires To DMM: 78" L (1981 mm), stranded, Ptfe insulated

Gross Weight: 2 lbs (0.9 kg)

Ordering Information:

5630 Type S Thermocouple	**$1,795**
5637 Type S Thermocouple	**1,895**
5638 Type S Thermocouple	**1,595**
9306 Probe Carrying Case for 5630/5638	**80**
9303 Probe Carrying Case for 5637	**230**

Phone: 800 438-4278
Fax: 801 785-7118

It takes lots of people to bring you Hart products. Here are just a few. Do you recognize any of them? Look for them at trade shows.

THERMISTOR PROBE — Range: –10°C to 110°C

Thermistor Probe	Model 5610
Better field stability than an RTD	
Higher resolution than RTDs	
High accuracy from –10°C to 110°C	
Affordable price	

If you're looking for a thermistor probe for use with a digital multimeter or high accuracy thermometer, the Hart Model 5610 probe will meet your needs at a price you can afford.

The 5610 is a high quality, ultrastable probe for precision temperature calibrations or measurements over the temperature range of –10°C to 110°C. It has higher resolution than a platinum probe for finer relative measurements. The nominal resistance of 10K ohms at 25°C, coupled with the probes precision stability and repeatability, give a resolution of 0.0001°C or better.

Each probe is supplied with a calibration table showing actual resistance, traceable to NIST, every 0.5°C over the probe range. The table values and the included interpolation equation are accurate to ±0.01°C.

In addition to the excellent accuracy, stability and resolution, this probe has better field stability than traditional PRTs. Its overall construction makes it less susceptible than PRTs to the bumps and stresses normally encountered in field conditions.

If you're working in difficult environments or have to take your probe outside the lab, Hart's 5610 durable thermistor probe is a better choice than a delicate PRT over the same temperature range.

The standard configuration includes gold-plated spade lugs. You can also order it with banana plugs or other connectors. This probe is excellent for any of Hart's multimeters or high accuracy thermometers.

Specifications — Model 5610

Resistance: Nominal 10,000 ohms at 25°C

Range: –10°C to 110°C

Calibration: R *vs.* T table with 0.5°C increments, interpolation equation furnished

Accuracy: Table and equation are accurate to ±0.01°C.

Stability: Better than ±0.01°C per year

Repeatability: Better than ±0.01°C

Dimensions: 0.125" dia. x 9" long (3.18 mm x 229 mm)

Construction: 316 S.S. sheath, Teflon insulated 2-wire cable with shield, 6ft.

Termination: Gold-plated spade lugs are standard. Other options available. Specify when ordering.

Instrumentation: Use with Hart Model 1506 or 1575 Thermometers or a Hart/Prema Hi-Res Digital Multimeter on pages 134–137.

Ordering Information:

5610 Thermistor Probe	**$650**
2601 Probe Carrying Case	**45**

Specify termination when ordering

See our complete line of cases on page 144.

BARE THERMISTOR PROBE — Range: –10°C to 110°C

Bare Thermistor Probe	Model 5611
Excellent accuracy	
Bare construction for fast response	
High temperature resolution	
Adaptable to many applications	

Like the Model 5610, the Hart Model 5611 is a high quality, ultrastable probe for precision temperature calibrations or measurements over the temperature range of –10°C to 110°C. However, the 5611 is a "bare" thermistor without the steel sheath and cable. The thermistor bead has a thin silicone rubber coating over its entire length to allow immersion in a water bath.

For applications requiring a smaller size probe with faster response times, the 5611 is the instrument of choice. Surface applications, air or gas measurements or calibrations that require an imbedded probe all benefit from the 5611's design.

The nominal resistance of 10K ohms at 25°C, coupled with the probe's precision stability and repeatability, give resolution to 0.0001°C or better.

Each probe is supplied with a calibration table giving actual resistance, traceable to NIST, every 0.5°C over the probe range. The table values and the included interpolation equation are accurate to ±0.01°C.

Many customers use the 5611 to automate product testing. The 5611 bare thermistor can be embedded in a test fixture and its resistance read with a digital multimeter. Or read temperature directly with Hart's 1506, or the Super-Thermometer. The 5611 provides a high accuracy, low cost traceable standard that's adaptable to many industrial requirements.

Specifications — Model 5611

Resistance: Nominal 10,000 ohms at 25°C

Range: –10°C to 110°C

Calibration: R *vs.* T table with 0.5°C increments, interpolation equation furnished

Accuracy: Table and equation accurate to ±0.01°C

Stability: Better than ±0.01°C per year

Construction: Bare thermistor bead with conformal coating of silicone, two leads

Termination: Gold-plated spade lugs are standard. Other options available. Specify when ordering.

Instrumentation: Use with Hart Model 1506 or 1575 Thermometers or a Hart/Prema Hi-Res Digital Multimeter on pages 134–137.

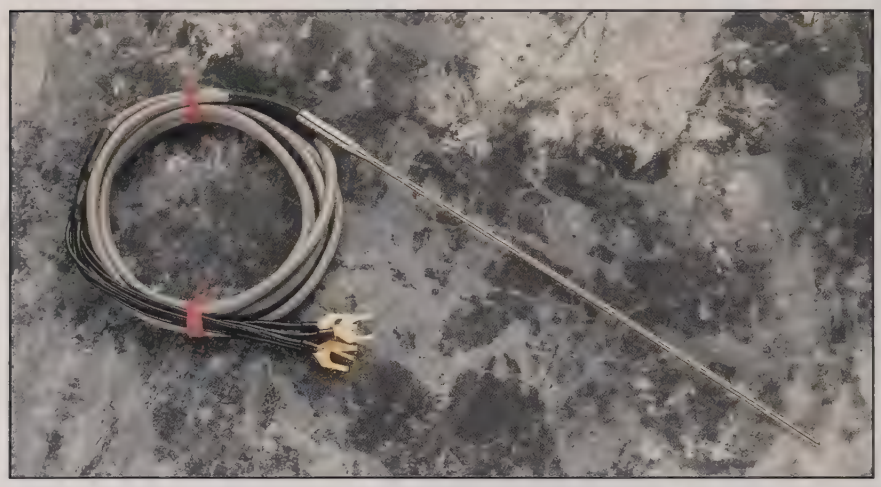
Ordering Information:

5611 Bare Thermistor	**$350**
2601 Probe Carrying Case	**45**

Specify termination when ordering

Phone: 800 438-4278
Fax: 801 785-7118

THERMISTOR STANDARDS PROBES



Thermistor Standards Probes	Series 5640
High accuracy and stability	
Resistant to mechanical shock	

Are you under the impression that thermistor probes are drift plagued sensors and aren't good calibration thermometers? You'll want to read this carefully because the Hart 5640 Series Thermistor Standards Probes will change your mind.

Each probe uses an ultrastable glass thermistor enclosed in a thin walled stainless steel tube. The basic semiconductor element is a bead of manganese, nickel and cobalt oxides mounted on 0.1 mm platinum wires. For long term stability, the thermistor is aged at various temperatures for 16 weeks. During the aging process, verification of the probe's stability is done to ensure performance to published specs.

The 5640, 5641 and 5642 thermistor probes are designed for the temperature range of 0°C to 60°C. The 5643 and 5644 probes span the 0°C to 100°C temperature range. They offer stability of either ±0.002°C or ±0.005°C. These stability levels are guaranteed for one full year.

Precision calibration, traceable to NIST, is provided with each probe. A computer generated table in increments of 0.01°C is furnished with each calibration based on the formula $R_T=\exp(A_0+A_1/T+A_2/T^2+A_3/T^3)$.

The constants for the formula are obtained from a polynomial regression performed on the calibration data. Over the range of 0°C to 60°C, calibration is done at the Triple Point of Water (0.01°C) and 15°C, 25°C, 30°C, 37°C, 50°C and 60°C. For the 0°C to 100°C temperature range, the additional calibration points of 80°C and 100°C are used.

Four-wire probes are calibrated using a comparison technique with a ratio bridge having an accuracy of 0.0002%. All resistance measurements are referenced to standard resistors calibrated by NIST. All temperature measurements are made using a standard platinum resistance thermometer which has been calibrated by NIST.

Why pay for an SPRT when you can get ±0.001°C accuracy from 0°C to 100°C in a "calibrated" thermistor probe for about one-third the cost of an uncalibrated SPRT?

Thermistor standards are rugged precision sensors suitable for use as secondary or working temperature standards for laboratory metrology applications. But because they generally are not affected by shock and vibration, you can use them in the most difficult field environments without worrying over calibration integrity.

Combine these probes with Hart's Model 1506 Thermometer to read directly in °C, °F or K. This combination gives you resolution of 0.0001 degrees and total system accuracy better than ±0.006°C. Combine one with the Super-Thermometer for total system accuracy to ±0.002°C

Compare the cost of a series 5640 calibrated probe and a 1506 thermometer to the cost of an uncalibrated SPRT. You'll find the thermistor/1506 is a top value standard between 0°C and 100°C.

Specifications

Model	Dia x Length	Range	Stability °C/Year	Accuracy 0–60°C	Accuracy 0–100°C	Wires
5640	25" x 9" (6.35 mm x 229 mm)	0°C–60°C	± 0.005°C	±0.0015°C		2
5641	125" x 4.5" (3.18 mm x 114 mm)	0°C–60°C	±0.002°C	±0.001°C		4
5642	125" x 9" (3.18 mm x 229 mm)	0°C–60°C	±0.002°C	±0.001°C		4
5643	125" x 4.5" (3.18 mm x 114 mm)	0°C–100°C	±0.005°C	±0.0015°C	±0.0025°C	4
5644	125" x 9" (3.18 mm x 229 mm)	0°C–100°C	±0.005°C	±0.0015°C	±0.0025°C	4

Ordering Information:

5640 Thermistor Probe	**$ 950**
5641 Thermistor Probe	**1,560**
5642 Thermistor Probe	**1,560**
5643 Thermistor Probe	**1,395**
5644 Thermistor Probe	**1,395**
9305 Carrying Case	**50**

ERTCO THERMOMETER SETS

If you need a liquid-in-glass thermometer set to cover –38°C to 405°C or –36°F to 761°F and you want it made to ASTM specifications, Hart now offers L.I.G. set 62–70C-FC or L.I.G. set 62–70F-FC.

These thermometers are made exactly to ASTM requirements and feature an ASTM number. Each ASTM thermometer is calibrated against NIST standards and comes with a calibration certificate showing corrections to the nearest tenth scale division traceable to NIST.

Each set incorporates the ice point (0°C or 32°F) as a reference point, enabling the user to validate and update the calibration document to ensure accurate temperature measurements over the life of the thermometers.

Both sets come packaged in a felt-lined storage case for easy handling and storage. These are the finest ASTM thermometers made.

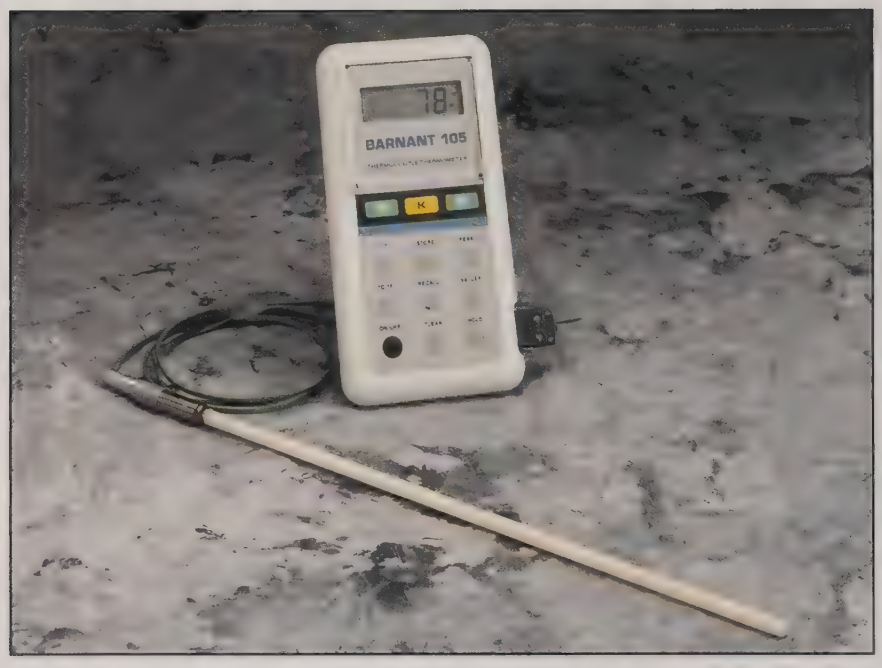
If you're looking for a zero point calibrator or deep-well baths for liquid-in-glass thermometer calibration, be sure to review Hart's complete line of calibration equipment for L.I.G. instruments.

Complete Sets of ASTM Precision Factory Calibrated (Certified) Thermometers

Cat. No.	No. of Thermometers	ASTM Nos.	Ranges Covered	Price
62–70C-FC	9	62C–70C	–38 to 405°C	$ 1,790
62–70F-FC	9	62F-70F	–36 to 761°F	1,790

Replacement Thermometers Purchased Separately

Cat No.	ASTM No.	Range	Div.	Length	Calibrated (Certified) at	Price
62C-FC	62C	–38 to 2°C	0.1°	379 mm	–37°, –30°, –20°, –10°, 0°C	$ 175
63C-FC	63C	–8 to 32°C	0.1°	379 mm	–7°, 0°, 10°, 20°, 30°C	150
64C-FC	64C	25 to 55°C	0.1°	379 mm	0°, 25°, 35°, 45°, 55°C	165
65C-FC	65C	50 to 80°C	0.1°	379 mm	0°, 50°, 60°, 70°, 80°C	165
66C-FC	66C	75 to 105°C	0.1°	379 mm	0°, 75°, 85°, 95°, 105°C	175
67C-FC	67C	95 to 155°C	0.2°	379 mm	0°, 100°, 110°, 130°, 150°C	200
68C-FC	68C	145 to 205°C	0.2°	379 mm	0°, 150°, 170°, 190°, 205°C	225
69C-FC	69C	195 to 305°C	0.5°	379 mm	0°, 200°, 235°, 270°, 305°C	230
70C-FC	70C	295 to 405°C	0.5°	379 mm	0°, 300°, 335°, 370°, 400°C	250
62F-FC	62F	–36 to 35°F	0.2°	379 mm	–35°, –15°, 0°, 15°, 32°F	175
63F-FC	63F	18 to 89°F	0.2°	379 mm	20°, 32°, 50°, 70°, 88°F	150
64F-FC	64F	77 to 131°F	0.2°	379 mm	32°, 80°, 95°, 115°, 130°F	165
65F-FC	65F	122 to 176°F	0.2°	379 mm	32°, 125°, 145°, 160°, 175°F	165
66F-FC	66F	167 to 221°F	0.2°	379 mm	32°, 168°, 185°, 200°, 220°F	175
67F-FC	67F	203 to 311°F	0.5°	379 mm	32°, 205°, 240°, 275°, 310°F	200
68F-FC	68F	293 to 401°F	0.5°	379 mm	32°, 300°, 340°, 370°, 400°F	225
69F-FC	69F	383 to 581°F	1.0°	379 mm	32°, 400°, 460°, 520°, 580°F	230
70F-FC	70F	563 to 761°F	1.0°	379 mm	32°, 570°, 640°, 700°, 760°F	250



Handheld Thermocouple Reference	Models 5515 and 5639
Low cost industrial reference thermometer	
Check thermocouples up to 1450°C	
Portable and easy to use	

If you've got to certify industrial thermocouples and you can't justify a high priced reference, this meter and probe will do the job.

The Type S Platinum/Platinum-Rhodium thermocouple is the thermocouple of choice when it comes to high temperature comparison calibration of industrial probes. Barnant makes a microprocessor based readout for the Type S thermocouple that gives great value for the money so we put it together for you with one of two probes and an optional system certification. You get a traceable reference at a price your application can justify.

This combination works great with the Hart Model 9113 Portable Furnace (page 116) to give you a complete comparison calibration setup to certify thermocouples. The 12" probe is a perfect length for the 9113 furnace. The 18" length fits our Model 9112 (page 118) furnace and is long enough for most other furnaces. Both probes use reference grade thermocouple material and feature a ceramic sheath.

The 5515 fits in the palm of your hand and runs off of a 9-volt battery. The touch type keypad is easy to use and clean, making it ideal for plant environments. In addition to reading type S thermocouples, you can switch to read types K and R. Resolution is 1° and you can read in °C or °F at the touch of a button. The memory feature stores and recalls up to 12 readings.

Each 5515 comes from Barnant with a certificate of conformance. For an additional $85 we'll certify the meter's accuracy in our lab using a NIST traceable thermocouple simulator. Data will be given in 100°C increments for the type S input from 0°C to 1400°C. The 5639 probes include a factory certificate giving traceability to a NIST test number. If you'd like a complete system certificate we'll test the probe and meter together in our lab against a NIST traceable reference thermocouple and we'll provide data at 5 temperatures (300°C, 500°C, 700°C, 900°C, 1100°C). The price of the standard system certificate is $195. Additional temperatures can be added for $40 each.

Specifications

5515 Meter:

Range:
- **Type R:** 0°C to 1767°C (32°F to 3213°F)
- **Type K:** –100°C to 500°C (–140°F to 932°F)
- **Type S:** 0°C to 1767°C (32°F to 3213°F)

Accuracy: ±0.25% of reading ±1°C

Resolution: 1°C or F

Power: 9-volt battery

5639 Type S Probe:

Range: 0°C to 1767°C (32°F to 3213°F)

Accuracy: 0°C to 600°C ±0.6°C
600°C to 1450°C ±0.1% of reading

Dimensions:
- **5639-12:** 0.25" (6.35mm) dia x 12" (305mm) lg.
- **5639-18:** 0.25" (6.35mm) dia x 18" (457mm) lg.

Ordering Information:

5515 Thermocouple Meter	**$225**
5639-12 Type S 12" Probe	**390**
5639-18 Type S 18" Probe	**490**
Calibration Options:	
1832 Certify Meter Only	**85**
1833 5-Point System Cert	**195**
Additional Points, each	**40**

HANDHELD RTD THERMOMETER — Model 5512

Handheld RTD Thermometer — Model 5512
–100°C to 500°C (–148°F to 932°F)
Accuracy to ±0.3°C
Includes system calibration for meter and probe combined
Easy recalibration

If you need an accurate handheld thermometer, you can't beat the Hart 5512 for accuracy, ease of use and price.

The probe is hard-wired to the thermometer and the two are calibrated together as a system to give you the least error possible in the combination you select. Calibration trim pots are accessible through the battery compartment so you won't have to take the 5512 apart when it's time to recalibrate the unit. Resolution is 0.1°C or F below 200 and 1°C or F above 200. The accuracy and range depend on the probe you choose from those offered at right.

Check dry-well calibrations anywhere, anytime, or compare the 5512 readings to sensors in the field for quick verification. Includes analog output for connection to any recorder or data acquisition device. The cable and output plug are included. Power is provided by a 9-volt battery. An AC adapter is optional.

In the 5512 package you get the probe and thermometer, a NIST traceable calibration certificate and a foam-lined attache carrying case. Each certificate includes actual data at three temperatures. Call for additional points of your choice at $40 each. This thermometer is a great value and will solve several of your measurement problems.

Model 5512-01 $445
°C Meter w/Handheld Probe
–100°C to 199.9°C ±0.3°C
Cal Points: 0°C, 100°C, 199°C

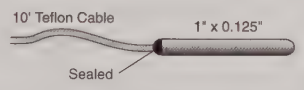
Model 5513-01 $445
°F Meter w/Handheld Probe
–148°F to 199.9°F ±0.5°F
200°F to 392°F ±2°F
Cal Points: 0°F, 199°F, 390°F

Model 5512-02 $445
°C Meter w/Penetration Probe
–100°C to 199.9°C ±0.3°C
Cal Points: 0°C, 100°C, 199°C

Model 5513-02 $445
°F Meter w/Penetration Probe
–148°F to 199.9°F ±0.5°F
200°F to 392°F ±2°F
Cal Points: 0°F, 199°F, 390°F

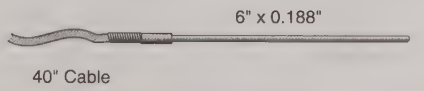
Model 5512-03 $465
°C Meter w/General Purpose Probe
–100°C to 199.9°C ±0.3°C
Cal Points: 0°C, 100°C, 199°C

Model 5513-03 $465
°F Meter w/General Purpose Probe
–148°F to 199.9°F ±0.5°F
200°F to 392°F ±2°F
Cal Points: 0°F, 199°F, 390°F



Model 5512-04 $495
°C Meter w/Wide Range Probe
–100°C to 199.9°C ±0.3°C
200°C to 500°C ±2°C
Cal Points: 0°C, 199°C, 500°C

Model 5513-04 $495
°F Meter w/Wide Range Probe
–148°F to 199.9°F ±0.5°F
200°F to 932°F ±3°F
Cal Points: 0°F, 199°F, 932°F



EUTECHNICS DIGITAL THERMISTOR METER — Model 5504

Eutechnics Digital Thermistor Meter	Model 5504
System accuracy of ±0.215°C	
Interchangeable thermistor probes	
Resolution of 0.01°C, –20°C to 130°C range	

If you're making temperature measurements in the –20°C to 130°C range you can have ±0.015°C accuracy in the Model 5504 Eutechnics Digital Thermistor Meter.

Any YSI Series 400 thermistor probe plugs into the ¼ inch phone jack, and total system error is less than ±0.215°C. With the 5674 probe your system error is less than ±0.07°C. Resolution is 0.01°C for monitoring small temperature changes.

Several temperature functions (such as HOLD, MIN/MAX, STORE and DELTA T) can be assigned to two of the four function keys on the front panel. You can then switch back and forth between the two selected functions with just a touch of a button.

The Model 5504 is powered by a 9V battery for complete portability and an AC adapter for use in the lab. There's an auto shut-off to conserve power and a low battery warning.

The 5504 is traceable to NIST. The YSI probes come with a preprinted form that certifies they were checked for accuracy against NIST traceable standards during manufacturing. If you'd like a "system" certificate, order our 4 point certification. We'll test your system against NIST traceable standards in our lab and your report will include data.

This instrument is new. It's priced right, it's very accurate, and it's completely portable. Hart brings you only the best in temperature calibration tools.

Specifications

Accuracy:
–20°C, ±0.016°C
0°C, ±0.015°C
60°C, ±0.023°C
130°C, ±0.156°C

Repeatability: 0.002°C to 0.01°C (–20°C to 100°C) 7 days typical

Sensor Type: YSI series 400 thermistors, 2252Ω at 25°C

Resolution: 0.01°

Power: 9V alkaline battery included

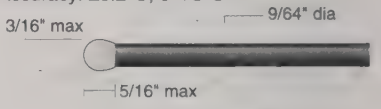
Interface: RS-232 included

Dimensions: 8.25" H x 4.0" W x 1.5" D

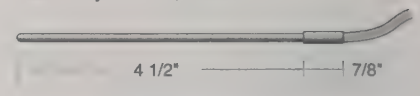
Ordering Information:

5504 Digital Thermistor Meter	**$515**
5312-001 RS232 Software	**80**
5312-002 RS232 10 ft cable	**20**
5312-003 AC Adapter	**40**
9305 Instrument Case	**50**
1853 4-pt. System Cert.	**200**
5671 General Purpose Probe	**90**
5672 Immersion Probe	**150**
5673 Surface Probe	**140**
5674 High Accuracy Probe	**215**

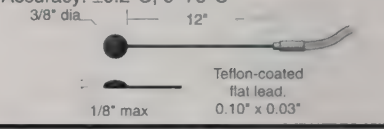
5671 Range: –40°C to 100°C
Accuracy: ±0.2°C, 0–75°C



5672 Range: –40°C to 150°C
Accuracy: ±0.2°C, 0–75°C



5673 Range: –40°C to 150°C
Accuracy: ±0.2°C, 0–75°C



5674 Range: –20°C to 130°C
Accuracy: ±0.05°C, 0–70°C

TEMPERATURE SCANNER — Model 5505

Temperature Scanner	Model 5505
Thermocouple and RTD meter	
Up to 40 channels of input	
Excellent as a calibration data logger	

If you've been thinking about buying a temperature logging instrument for collecting inputs from thermocouples or RTDs under calibration, Hart is offering the Model 5505 Temperature Scanner made by Azonix. It features 18-bit precision resolution reading temperatures to 0.01°C with accuracies to ±0.3°C for thermocouples and ±0.1°C for RTDs.

With four plug-in input card slots and a variety of available cards, the scanner is configurable for 2 to 40 input channels. It handles any combination of 7 thermocouple types and practically any mix of RTDs. There's also a printer output option for manual collection of data and optional RS-232 interface for automated data collection.

As compared to digital multimeter alternatives, the Model 5505 Scanner reads out in °C or °F rather than requiring the conversion of millivolt or ohm data into temperature. Unlike DMMs, the scanner has cold junction compensation built-in for thermocouple calibration, thus eliminating the need for an ice bath or other external compensation.

The 5505 can be used with a separate reference instrument for collection of test sensor data only. It can be used with a secondary standards type RTD connected to one channel while it collects input from up to 30 other thermocouples. One channel can be connected to a type S thermocouple as a standard while up to 39 other inputs from thermocouples under calibration are compared to the standard. The 5505 can be used as a multiple input temperature readout instrument with accuracy of ±0.3°C at 0°C and ±0.6°C at 500°C.

This is the most flexible, most accurate data logger available anywhere.

Specifications — Model 5505

Mainframe: 18-bit 240,000 count A/D converter, µP based instrument with LED display of reading value, channel number and scale. Four slots for input cards, up to 40 channels possible. High and low alarms for each channel are user set. Minimum and maximum for each input can be recalled.

Thermocouple Input: 10 channels per input card, any mix of types J, K, S, R, T, E, B and N. Local or remote junction compensation. Fully floating and isolated inputs. 0.05°C typical resolution. ±0.3°C typical accuracy. Full NIST 125 range for all types except B. Displays C, F, mV or Kelvin. Up to four TC input cards can be installed in the mainframe.

RTD Input: 3-wire (4-wire available) RTD sensor inputs, 2 or 6 per card, 25 to 1000 ohm. 385 alpha (DIN 43760) is preprogrammed. User may enter others through keyboard. 0.005°C typical resolution. ±0.01°C typical accuracy. –200°C to 850°C range. Displays °C, °F, or K.

Calibration: Digital, keyboard entered

Power: 110/220 VAC ±20%

Operating Temperature: 0°C to 60°C

Size: 4" H x 8.05" W x 7.2" D (102 mm x 205 mm x 183 mm)

Weight: Approx. 15 lbs (6.8 kg)

Ordering Information:

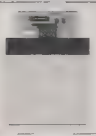
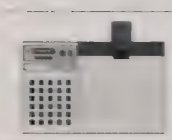
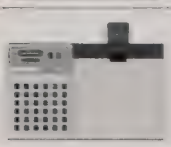
5505 Temp Scanner Base	**$1,495**
5302-055 10-Input TC Card	**1,075**
5302-019 6-Input RTD Card	**1,075**
Call Hart for other RTD Input Cards	
5302-002 RS-232C Interface	**395**
5302-020 Math Package	**415**

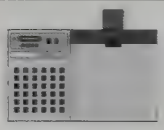
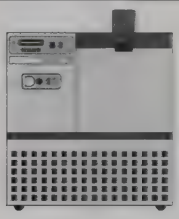
INTRODUCTION TO BATHS

Benchtop Baths

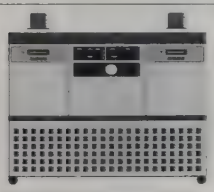
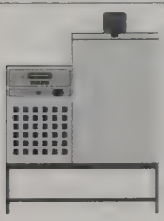
	Model	Range	Stability	Depth	Features	Price	Page
	6035 Hi-Temp Benchtop Bath	35°C to 300°C 95°F to 571°F	35°C ±0.005°C 200°C ±0.007°C 300°C ±0.015°C	9.5" 241 mm	Benchtop size Safety heat shield Small 2.1 gallon tank	$3,825	62
	6025 Mid-Range Benchtop Bath	35°C to 205°C 95°F to 401°F	35°C ±0.005°C 100°C ±0.005°C 200°C ±0.007°C	9.5" 241 mm	Affordable Weighs less than 26 lbs. Optional RS-232 and IEEE-488	3,290	61
	7025 Low-Temp Benchtop Bath	–20°C to 110°C –4°F to 230°F	–20°C ±0.01°C 35°C ±0.005°C 100°C ±0.005°C	9.5" 241 mm	Small footprint ±0.005°C uniformity	$4,350	60

Standard Baths

	Model	Range	Stability	Depth	Features	Price	Page
	6050 Ultra High-Temp Calibration Bath	40°C to 500°C 68°F to 932°F	160°C ±0.002°C 300°C ±0.005°C 500°C ±0.015°C	12" 304 mm	Better stability than sand baths High temperature, low gradients	$9,290	74
	6045 High-Temp Calibration Bath	40°C to 400°C 68°F to 752°F	45°C ±0.001°C 200°C ±0.003°C 400°C ±0.01°C	12" 304 mm	Designed for use with oil or salts High resolution setpoint to 0.00018°C	7,350	73
	6022 Deep Oil Bath	40°C to 300°C 68°F to 572°F	40°C ±0.001°C 100°C ±0.003°C 300°C ±0.01°C	18" 465 mm	Deep tank for SPRT or L.I.G. thermometers Optional fluid level adapter Uses silicone oil to 300°C	6,750	76
	6010 Low-Range Oil Bath	40°C to 150°C 68°F to 302°F	25°C ±0.001°C 150°C ±0.004°C	12" 304 mm	Moderate range and price	5,650	71
	6020 Mid-Range Bath	40°C to 300°C 68°F to 572°F	25°C ±0.001°C 100°C ±0.003°C 300°C ±0.006°C	12" 304 mm	Broad range to 300°C	6,250	72
	6024 44 Liter Bath			13.25" 337 mm	Larger access opening and tank size	6,950	81
	7011 Mid-Range Calibration Bath	–10°C to 110°C 14°F to 230°F	0°C ±0.001°C 25°C ±0.0005°C 100°C ±0.0008°C	12" 304 mm	Self-contained refrigeration Best-priced ultra-stable cooled bath ±0.002°C uniformity	6,950	64
	7012 Deep Mid-Range Calibration Bath	–10°C to 110°C 14°F to 230°F	0°C ±0.001°C 25°C ±0.0005°C 100°C ±0.0008°C	18" 465 mm	Maintains up to 5 WTP cells Extra large access opening: 6.3" x 11.5" (162 mm x 292 mm)	7,900	66
	7008 44 Liter Refrigerated Bath	–10°C to 110°C 14°F to 230°F	0°C ±0.001°C 25°C ±0.0005°C 100°C ±0.0008°C	13.25" 337 mm	Large tank for larger mass immersion ability Optional RS-232 and IEEE-488 interface with refrigeration control	$7,895	80

	Model	Range	Stability	Depth	Features	Price	Page
	7030 Special Range Bath	–30°C to 150°C –22°F to 302°F	±0.01°C	11" 230 mm	Fast heating and cooling Small 1.8 gallon tank Optional fluid level adapter for L.I.G.s	$9,995	77
	7040 Low-Temp Calibration Bath	–40°C to 110°C –40°F to 230°F	–40°C ±0.002°C 0°C ±0.001°C 25°C ±0.0005°C 100°C ±0.003°C	12" 304 mm	Self-contained single stage refrigerator Microprocessor based digital controller	9,200	66
	7041 44 Liter Bath			13.25" 337 mm	Larger tank working area than 7040	10,200	61
	7037 Deep Low-Temp Calibration Bath	–40°C to 110°C –40°F to 230°F	–40°C ±0.002°C 0°C ±0.001°C 25°C ±0.0005°C 100°C ±0.0008°C	18" 457 mm	Lowest temperature deep-well bath Mercury cell maintenance bath Full 18" depth	9,950	67
	7060 Low-Temperature Bath	–60°C to 110°C –76°F to 230°F	–60°C ±0.003°C 25°C ±0.001°C 100°C ±0.003°C	12" 304 mm	Reaches –60°C with standard refrigeration	13,995	69
	7061 44 Liter Bath			13.25" 337 mm	More depth and volume than 7060	14,295	61
	7080 Ultra Low-Temp Calibration Bath	–80°C to 110°C –112°F to 230°F	–40°C ±0.002°C 25°C ±0.001°C 100°C ±0.003°C	12" 304 mm	Best stability in ultra low-temp bath	15,995	70
	7081 44 Liter Bath			13.25" 337 mm	Large tank and bath working area	$16,295	61

Special Application Baths

	Model	Range	Stability	Depth	Features	Price	Page
	7015 Standard Resistor Bath	0°C to 110°C 32°F to 230°F	25°C ±0.0005°C	13.25" 337 mm	Ultra-stability and performance for maintaining standard resistors Large access and workspace Splash and spill resistant lid design	$12,595	79
	7013 Double-Well Calibration Bath	–100°C to 300°C –148°F to 572°F	–100°C ±0.03°C 0°C ±0.01°C 300°C ±0.03°C	11" 280 mm	Two calibration wells Broadest range calibration bath Lowest temperature without liquid nitrogen	29,900	78
	6055 Hi-Temp Deep Well	150°C to 550°C 302°F to1022°F	±0.005°C typical	17" 432 mm	L.I.G. sighting channel	14,500	82
	6054 Mid-Range Deep Well	50°C to 320°C 122°F to 608°F	±0.005°C typical	24" 610 mm	Maintains fluid level	14,300	
	7007 Refrigerated Deep Well	–5°C to 110°C 20°F to 230°F	±0.001°C typical	24" 610mm	Large 9 inch diameter workspace	$13,600	

LOW-TEMP BENCHTOP BATH –20°C to 110°C

Low-Temp Benchtop Bath	Model 7025
Economical price	
Excellent stability	
Small footprint	

If you're looking for a low cost benchtop bath the new Model 7025 features temperatures down to –20°C and up to 110°C.

Like all Hart baths, this unit is made especially for calibration. It has the best accuracy, stability and control features found on any bath in this price range.

The 9 inch depth covers many general purpose applications. The access opening is 3.25 inches by 5.75 inches for inserting several probes at one time. The small tank uses less fluid than other baths to save supply costs and speed up cooling and heating between temperature changes. Its small footprint lets you put it almost anywhere in the lab, and it's light enough to take it with you.

Bath stability is ±0.005°C over most of the range and ±0.01 at the outermost temperature of –20°C. Uniformity is ±0.005°C. Like all Hart baths, these specs are measured in the bath fluid under normal operating conditions, not in an isothermal block or under comparison calibration methods. This means you can actually achieve better performance under special circumstances, such as the use of isothermal blocks.

If you need automation, ask for the optional interface package to connect the bath to your PC's RS-232 port. Add the IEEE option to the interface for IEEE-488 systems. Lexan or stainless steel covers are available, as are carts and other options.

Why buy something that wasn't designed for what you do? Don't be misled: no one makes a bath that works or performs like a Hart bath. No one.

Specifications Model 7025

Range: –20°C to 110°C

Stability: –20°C ±0.01°C
35°C ±0.005°C
100°C ±0.005°C

Uniformity: ±0.005°C

Temperature Setting: Digital display with pushbutton data entry

Setpoint Resolution: 0.01°C
High Resolution Mode: 0.00018°C

Display Temp. Resolution: 0.01°C

Digital Setting Accuracy: ±0.5°C

Digital Setting Repeatability: ±0.01°C

Access Opening: 3.25" x 5.75" (83 mm x 146 mm)

Depth: 9.5" (241 mm)

Wetted Parts: 304 Stainless Steel

Power: 104 to 126 VAC, 60 Hz (240 VAC, 50 Hz available, add "-E" to the model number.)

Volume: 2.1 gallons (8 liters)

Size: 12" H (to bath surface) x 20" W x 15" D (305 mm x 790 mm x 381 mm)

Interface Package: Available with an RS-232 serial computer interface for setting bath temperature via remote computer. For IEEE-488 add the 2001-IEEE to the interface package. See page 85.

Ordering Information:

7025 Bath	**$4,350**
2001-7025 Interface Pkg.†	**795**
2001-IEEE Add for IEEE	**500**
2012 Spare Lexan Access Cover	**85**
2013 Spare S.S. Access Cover	**85**

†*Automates refrigeration valves and heater controls and accesses digital controller through an RS-232 port.*

MID-RANGE BENCHTOP BATH — Range: 35°C to 205°C

Mid-Range Benchtop Bath	Model 6025
Small well for reduced fluid costs	
Heats to 200°C in one hour	
Digital bath controller	
Economical price	

Hart's most economical bath, the Model 6025, is becoming the standard for temperature calibration between 35°C and 205°C. Weighing less than 26 pounds and taking up slightly more than one square foot of counter space, this benchtop calibration bath cuts in half the equipment costs for comparison calibrations in this temperature range.

Even at this price and size, Hart guarantees stability of ±0.005°C (see specs). No other manufacturer provides the cost/benefit ratio found in this instrument. Last year many Hart customers bought the 6025 for use as a dedicated calibration station in their labs.

The 6025 is built from the same high quality parts as found in other Hart products; all wetted parts are stainless steel including the entire bath top. This bath is designed to operate properly and look good for years.

In addition, the Model 6025 comes with Hart's digital microprocessor-based bath controller. You can set bath operating temperatures and safety cut-out points electronically.

You can also automate your 6025 with the optional interface package. It lets you automatically set all operating parameters any time you want with your PC.

See our selection of bath fluids on page 92.

Specifications — Model 6025

Range: 35°C to 205°C

Stability: 35°C ±0.005°C
100°C ±0.005°C
200°C ±0.007°C

Uniformity: ±0.005°C

Temperature Setting: Digital display with pushbutton data entry

Setpoint Resolution: 0.01°C
High Resolution Mode: 0.00018°C

Display Temp. Resolution: 0.01°C

Digital Setting Accuracy: ±0.5°C

Digital Setting Repeatability: ±0.01°C

Access Opening: 3.25" x 5.75" (83 mm x 146 mm)

Depth: 9.5" (241 mm)

Wetted Parts: 304 Stainless Steel

Power: 104 to 126 VAC, 60 Hz (240 VAC, 50 Hz available, add "-E" to the model number.)

Volume: 2.1 gallons (8 liters)

Size: 12" H (to bath surface) x 12" W x 15" D (305 mm x 305 mm x 381 mm)

Interface Package: Available with an RS-232 serial computer interface for setting bath temperature via remote computer. For IEEE-488 add the 2001-IEEE to the interface package (see page 85).

Ordering Information:

6025 Bath	**$3,290**
2001-6025 Interface Pkg.†	**645**
2001-IEEE Add for IEEE	**500**
2012 Spare Lexan Access Cover	**85**
2013 Spare S.S. Access Cover	**85**

†*Automates heater controls and accesses digital controller through an RS-232 port.*

HI-TEMP BENCHTOP BATH — Range: 35°C to 300°C

Hi-Temp Benchtop Bath	Model 6035
Best price/performance ratio in the industry	
Digital microprocessor-based bath controller	
Broad temperature range	
Reduced fluid expense with 2 gallon test well	

Another in Hart's line of economically priced calibration instruments is the Model 6035 for calibrations between 35°C and 300°C.

The 6035 features the excellent stability of ±0.005°C and comes standard with Hart's digital microprocessor-based bath controller. And even with its perforated safety shield, it still weighs less than 35 pounds and takes up little more than one square foot of counter space.

The well opening is 18 square inches and provides access to the 9.5 inch deep bath tank that holds 2.1 gallons of calibration bath oil. The Model 6035 reduces the cost of equipment, energy and fluids without reducing the performance or calibration throughput of the bath.

With the addition of an interface package, you can automate the 6035 with your PC for convenient operation.

Who else offers this stability, this temperature range, and an RS-232 port with this quality of construction for this price?

Specifications — Model 6035

Range: 35°C to 300°C

Stability:

35°C	±0.005°C
100°C	±0.005°C
200°C	±0.007°C
300°C	±0.015°C

Uniformity: ±0.005°C

Temperature Setting: Digital display with pushbutton data entry

Setpoint Resolution: 0.01°C
High Resolution Mode: 0.00018°C

Display Temp. Resolution: 0.01°C

Digital Setting Accuracy: ±0.5°C

Digital Setting Repeatability: ±0.02°C

Access Opening: 3.25" x 5.75" (83 mm x 146 mm)

Depth: 9.5" (241 mm)

Wetted Parts: 304 Stainless Steel

Power: 104 to 126 VAC, 60 Hz (240 VAC, 50 Hz available, add "-E" to the model number.)

Volume: 2.1 gallons (8 liters)

Size: 13.5" H (to bath surface) x 12" W x 15" D (305 mm x 305 mm x 381 mm)

Safety Shield: Perforated safety shield installed to protect user from inadvertent contact with hot bath surface.

Interface Package: Available with an RS-232 serial computer interface for setting bath temperature via remote computer. For IEEE-488 add the 2001-IEEE to the interface package (see page 85).

Ordering Information:

6035 Bath	**$3,825**
2001-6035 Interface Pkg.†	**645**
2001-IEEE Add for IEEE	**500**
2013 Spare S.S. Access Cover	**85**

†*Automates heater controls and accesses digital controller through an RS-232 port.*

See page 85 for computer interface information.

COMPLETE CALIBRATION PACKAGE –20°C to 300°C

Complete Calibration Package	Order No. 9903
Starter package includes Hart baths and a reference thermometer	
Perform comparison calibrations with uncertainties to ±0.03°C	
Includes it's own lab cart	

If you want a mobile calibration station or you're adding temperature calibration to your lab and want an easy way to start, this package gives you everything you need to calibrate thermometers from –25°C to 300°C. We've combined some of our most popular instruments to make the purchasing and set-up process easy.

The 9903 comes with two Hart benchtop baths. The 7025 operates from –20°C to 110°C. The 6035 covers 35°C to 300°C depending on your fluid choice. The two baths provide a wide temperature range for flexibility.

Hart's 1506 thermometer is the reference readout. It has two channels so you can dedicate one probe to each bath. Calibrated 5614 probes are included with a system certification at no extra charge. Just put the 1506 on the cart's shelf, immerse the probes in the baths and you're ready to calibrate. We also offer the same package without the 1506 Thermometer in case you already have a standard you want to use with the baths.

Each system comes with it's own cart. This one was designed specifically for temperature calibration instruments. It has 4-inch soft rubber casters to quietly glide anywhere in your plant. Foot brakes lock the cart in place when you're ready to work. The primary work surface holds your baths and a secondary instrument shelf above and slightly behind holds the 1506 and any instruments you're calibrating. The edge lip keeps instruments from accidently falling off the back. A built-in probe storage rack keeps hot probes out of the way between calibrations.

The cart framework is tubular steel and is welded for strength. The epoxy finish is durable and easy to clean. The only assembly required is the bolting on of the top shelf, which takes just a few minutes. The foot rest is stainless steel and is wide enough for use as a storage shelf. Power strip and cord wrap are included. When you order your package you can select one of two drawer options. The 2952 Utility Drawer is 3" high, 19" wide and 22" deep for tools, probes, etc. The 2953 File Drawer is 16.5" wide, 18" deep and 12" high for records, forms or large items.

This is only one of our complete calibration packages. If you're interested in something different or for another application—call us and we'll give you a quote.

What You Get (9903 package)

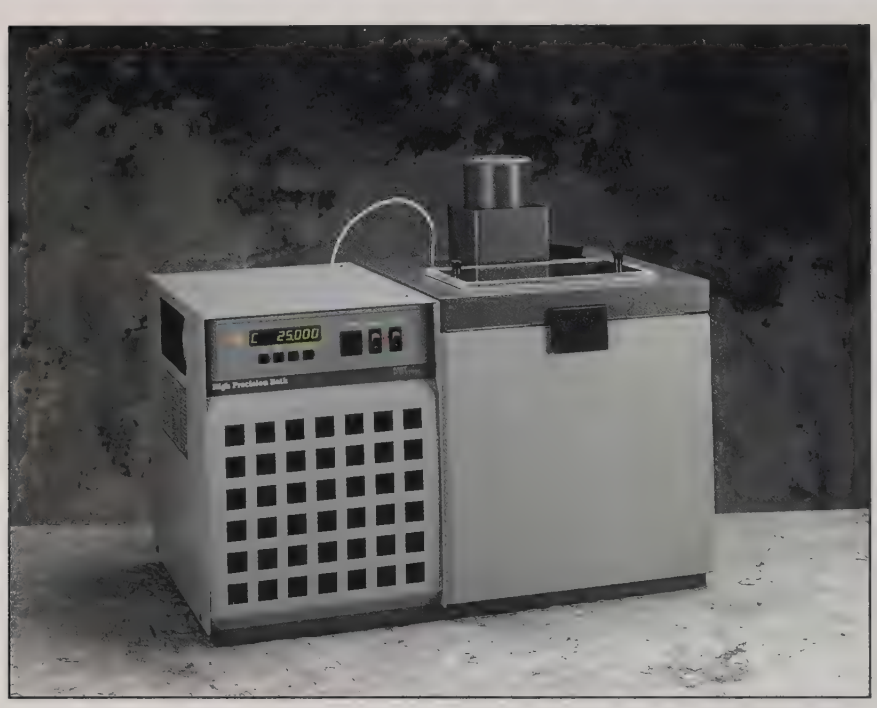
- 7025 Bath page 60
- 6035 Bath page 62
- 1506 Thermometer page 34
- Two 5614 Probes page 47
- System Certification
- 2901 Lab Cart

Ordering Information:

9903 Package, –20°C to 300°C	**$14,365**
9904 Package, same as 9903 without the 1506 and probes	**9,570**
2952 Utility Drawer	**155**
2953 File Drawer	**175**
2901 40" Cart Only	**1,395**
2902 55" Cart Only	**1,595**

Bath fluid is not included. See page 93 and call us for a recommendation.

MID-RANGE CALIBRATION BATH



Mid-Range Calibration Bath	Model 7011
Built-in refrigeration for temperatures to –10°C	
Self-contained benchtop or portable cart use	
Smallest possible gradients	
Precision digital bath controller	

Our most popular and versatile bath choice for calibration laboratories is the Hart Model 7011. For calibration work between –10°C and 110°C, nothing in the industry achieves better performance.

And if you don't believe us, just ask the world's largest manufacturer of medical thermistors, Thermometrics. They use Hart Model 7011 baths to test sensors manufactured in their plants in the U.S. and overseas. No other bath maker meets Thermometrics' stringent quality, performance and price requirements.

In fact, they use the 7011 to calibrate one of their sensor products featuring accuracy to ±0.001°C.

Of course, Thermometrics is not alone. McDonnell Douglas, Los Alamos National Labs, Chevron Oil, Florida Power, Sandia National Labs, U.S. Department of Energy, Westinghouse, Delco Electronics and Varian Corporation, among others, rely on Hart calibration baths and other Hart products for their own manufacturing, calibration and quality control jobs.

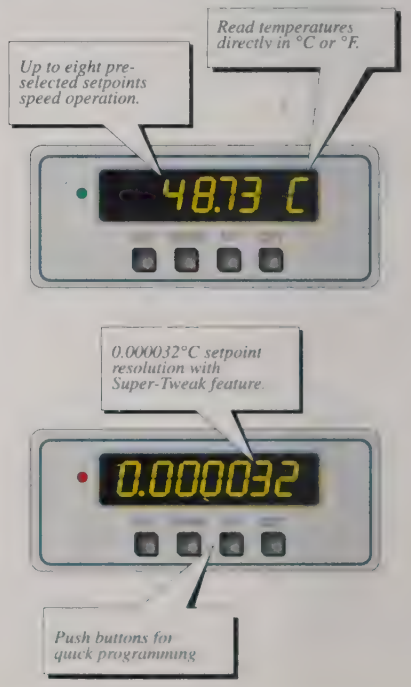
Exceptional Hart bath performance comes from advanced heat port engineering coupled with a high stability thermistor temperature controller for bath stabilities to ±0.0005°C. Built-in refrigeration makes the Model 7011 easy to use without sacrificing critical specs. With the 7011, you can forget about external cooling.

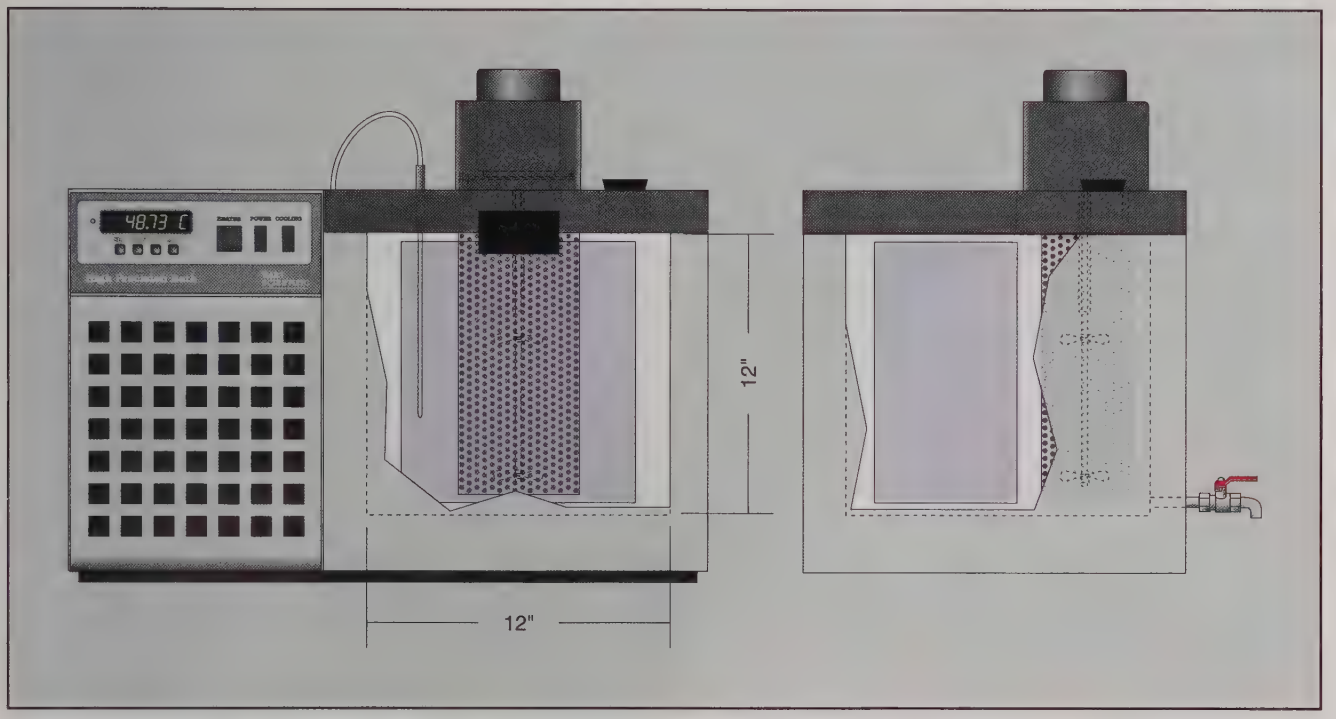
Hart's digital bath controller displays actual bath temperature to 0.01°C resolution. In the 7011, standard setpoint resolution is 0.002°C. However, in our "Super-Tweak" resolution mode, the controller display shifts to a higher resolution display so you can adjust the bath temperature setpoint out to the fifth decimal place. Although thermal noise in the bath is measured at four decimal places, the "Super-Tweak" function gets your bath temperature closer to an absolute setpoint value than any other bath on the market.

In addition, Hart's controller is programmable for preselected temperature setpoints. Up to eight of your most often-used settings are recallable at the touch of a button.

The frequently used calibration points of 0°C and 100°C are in the workhorse temperature range of the 7011. Many calibration labs have the Hart Model 7011 in the dedicated role of an "ice bath", leaving the unit set constantly to 0°C.

For convenience, quality, price and performance, the Model 7011, like many Hart calibration baths, is exceptional.


Read temperatures directly in °C or °F.
Up to eight pre-selected setpoints speed operation.
48.73 C
0.000032°C setpoint resolution with Super-Tweak feature.
0.000032
Push buttons for quick programming



The 7011 bath with the working well-area shown by the colored area in the cutaways. Note the absence of test-well obstructions like heaters and cooling coils. The stirring propeller is behind the protection grill behind the test-well area. See the drawings on page 90 for more details.

Specifications Model 7011

Range: –10°C to 110°C

Stability: 0°C ±0.001°C
25°C ±0.0005°C
100°C ±0.0008°C

Uniformity: ±0.001°C

Temperature Setting: Digital display with pushbutton data entry

Setpoint Resolution: 0.002°C
High Resolution Mode: 0.00003°C

Display Temp. Resolution: 0.01°C

Setting Accuracy: ±1°C
(0°C to 100°C)

Digital Setting Repeatability: ±0.005°C

Heaters: 500 and 1000 watts

Cooling Capacity: 100 to 200 watts

Access Opening: 5" x 10" (127 mm x 254 mm)

Depth: 12" (304 mm)

Wetted Parts: 304 Stainless Steel

Power: 104 to 126 VAC, 60 Hz, 15 amps (240 VAC, 50 Hz available, add "-E" to the model number.)

Volume: 6.6 gallons (25 liters)

Weight: 140 lbs (63.5 kg)

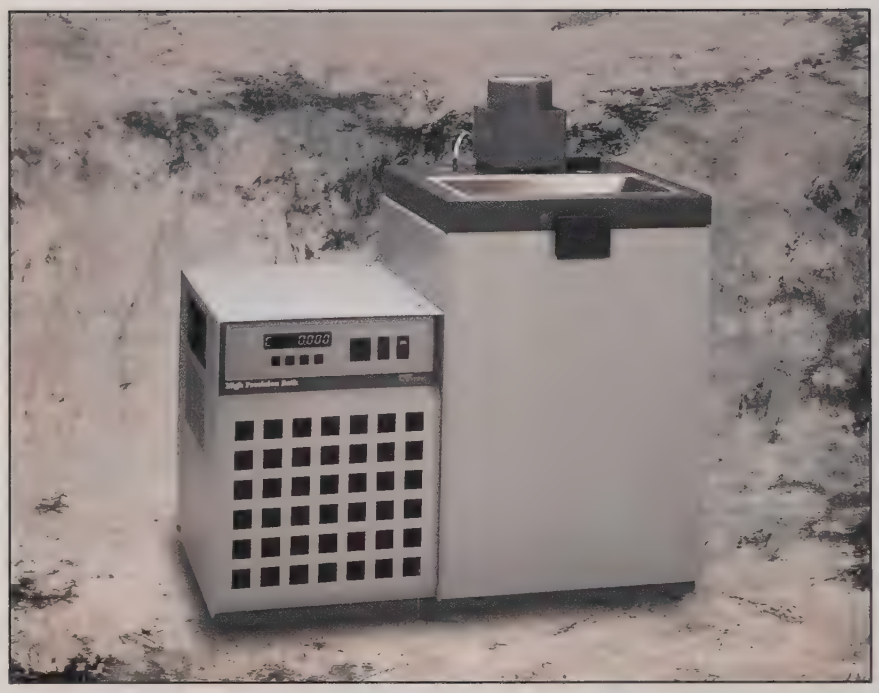
Size: 20.5" H x 27" W x 15.5" D (521 mm x 685 mm x 394 mm)

Interface Package: The 7011 cabinet is not large enough for installation of automated refrigeration controls. Order the Model 7008 on page 80 if a computer interface is desired.

Ordering Information:

7011 Bath	**$6,950**
2010 Spare Lexan Access Cover	**140**
2071 Floor Cart with Casters	**395**

DEEP MID-RANGE BATH — Range: –10°C to 110°C



Deep Mid-Range Bath	Model 7012
18 inches deep	
Most popular temperature range	
Maintains Water Triple Point Cells	
Superior stability	

Several Hart customers have asked us for a deeper version of our popular Model 7011 Refrigerated Bath. Our Model 7012 gives you a depth of 18 inches, making it ideal for long probe calibrations and comparison calibrations of SPRTs. Hart's trademark bath stability makes the 7012 perfect for maintenance of Triple Point of Water Cells. Up to four can be suspended in the bath with our optional holding fixture.

The 7012 covers the –10°C to 110°C temperature range, meeting a number of application requirements in one bath. Stability at 0°C is ±0.001°C or better. At 25°C the 7012 achieves ±0.0005°C stability. The bath fluid is well stirred to eliminate both horizontal and vertical gradients throughout the extra deep bath tank.

Why spend $18,000 with another company simply to duplicate these specs when no one beats Hart's performance at any price? Hart delivers, supports and engineers the whole package for performance and your convenience.

The Model 7012 is available with a holding fixture for Triple Point of Water Cells. It can handle up to five triple points simultaneously of either the popular Hart design or other cells you may have. This same fixture also lets you pre-chill your SPRTs before inserting them into the TPW Cells.

The combination of Hart's Model 7012 bath and 2027 Triple Point Fixture gives you an unbeatable method of maintaining your zero point for days at a time with no mess, hassle or time consuming preparation.

Specifications — Model 7012

Range: –10°C to 110°C

Stability:
0°C ±0.001°C
25°C ±0.0005°C
100°C ±0.0008°C

Uniformity: ±0.001°C

Temperature Setting: Digital display with pushbutton data entry

Setpoint Resolution: 0.002°C
High Resolution Mode: 0.00003°C

Actual Temp Resolution: 0.01°C

Setting Accuracy: ±1°C (0°C to 100°C)

Digital Setting Repeatability: ±0.005°C

Heaters: 500 and 1,000 watts

Access Opening: 6.375" x 11.5" (162 mm x 292 mm)

Depth: 18" (465 mm)

Wetted Parts: 304 Stainless Steel

Power: 104 to 126 VAC, 60 Hz, 15 amps (220 VAC, 50 Hz available, add "-E" to the model number.)

Volume: 9.5 gallons (36 liters)

Weight: 150 lbs (68 kg)

Size: 26" H x 27" W x 15.5" D (660 mm x 686 mm x 394 mm)

Ordering Information:

7012 Deep Mid-Range Bath	**$7,900**
2027-5901 Holding Fixture for TPW Triple Points	**600**

See page 20 for Triple Point of Water Cell

LOW-TEMP DEEP WELL BATH — Range –40°C to 110°C

Low-Temp Deep Well Bath	Model 7037
18 inches deep for long-stem SPRTs	
Lowest temperature offered in a deep-well bath	
No liquid nitrogen or external cooling connections	
Minimal horizontal and vertical gradients	

Hart's Model 7040 bath is one of our best selling baths for work below ambient, and now Hart has the Model 7037 that also reaches –40°C but is a full 18 inches deep for calibration of long-stem SPRTs or glass thermometers.

The 7037 uses the same reliable refrigeration as the Model 7040 for trouble-free chilling and superb stability. Don't waste money and time on external cooling units. Uniformity, accuracy and stability are the mark of Hart's fine quality baths.

The Model 7037 is available with complete computer automation, including computer interface and electronic valves for absolute temperature control. Heating and cooling are balanced against each other to save energy and cut operating costs while keeping the best specs in the industry.

This bath more than pays for itself in labor savings. Everyone is under pressure to do more with less, and you can do it without introducing more error into your work. Call today to discuss any application you might have in mind, including military applications, aerospace work, semiconductor manufacturing, electronic component testing and the calibration of standards thermometers.

Specifications — Model 7037

Range: –40°C to 110°C

Stability:
–40°C ±0.002°C
0°C ±0.001°C
25°C ±0.0005°C
100°C ±0.0008°C

Uniformity: ±0.002°C

Temperature Setting: Digital display with pushbutton data entry

Setpoint Resolution: 0.01°C
High Resolution Mode: 0.00007°C

Actual Temp Resolution: 0.01°C

Digital Setting Accuracy: ±1°C

Digital Setting Repeatability: ±0.01°C

Heaters: 500 and 1,000 watts

Access Opening: 5" x 10" (127 mm x 254 mm)

Depth: 18" (457 mm)

Wetted Parts: 304 Stainless Steel

Power: 104 to 126 VAC, 60 Hz, 15 amps (220 VAC, 50 Hz available, add "-E" to the model number.)

Volume: 9.5 gallons (36 liters)

Weight: 150 lbs (68 kg)

Size: 28" H x 30.25" W x 19" D (711 mm x 768 mm x 483 mm)

Ordering Information:

7037 Deep Low-Temp Bath	**$9,950**
2001-7037 Interface Pkg.†	**3,559**
2001-IEEE Add for IEEE	**500**
2010 Spare Lexan Access Cover	**140**
2073 Floor Cart with Casters	**395**

†*Automates refrigeration valves and heater controls and accesses digital controller through an RS-232 port.*

LOW-TEMP CALIBRATION BATH — Range: –40°C to 110°C

Low-Temp Calibration Bath	Model 7040
No liquid nitrogen or external cooling needed	
User controlled valves for power balance	
Microprocessor based digital controller	

For the temperature range of –40°C to 110°C, the Hart Model 7040 features self-contained refrigeration, eliminating the need for inconvenient and time-consuming external cooling. Single stage refrigeration makes the Model 7040 less costly than dual-stage systems, while still producing cold temperatures low enough for most calibrations.

This bath is one of our most popular for military applications, aerospace work, semiconductor manufacturing, electronic component testing, and the calibration of standards thermometers.

The U.S. Navy, AT&T, ARCO, Grumman and Lockheed rely on the Hart Model 7040 for low temperature calibrations.

The Model 7040 is available with a computer interface option for remote setting of bath temperature and heating and cooling control.

The Hart computer interface handles the highest level of bath automation in the industry. Rather than simply setting temperatures, Hart's computer interface allows automated control of all heating elements and cooling valves for precise balance of heating and cooling cycles. Not only does this improve bath stability and temperature accuracy, it saves energy and cuts operating costs.

Be sure to read the article "Considering an Automated System" on page 84. Automation more than pays for itself in labor savings.

Specifications — Model 7040

Range: –40°C to 110°C

Uniformity: ±0.001°C

Stability: –40°C ±0.002°C
0°C ±0.001°C
25°C ±0.001°C
100°C ±0.003°C

Temperature Setting: Digital display with pushbutton data entry

Setpoint Resolution: 0.01°C
High Resolution Mode: 0.00007°C

Display Temp. Resolution: 0.01°C

Digital Setting Accuracy: ±1°C

Digital Setting Repeatability: ±0.01°C

Heaters: 500 and 1000 watts

Cooling Capacity: 100 to 200 watts

Access Opening: 5" x 10" (127 mm x 254 mm)

Depth: 12" (304 mm)

Wetted Parts: 304 Stainless Steel

Power: 104 to 126 VAC, 60 Hz, 18 amps (240 VAC, 50 Hz available, add "-E" to the model number.)

Volume: 6.6 gallons (25 liters)

Weight: 140 lbs (63.5 kg)

Size: 23.5" H x 30.25" W x 19" D (597 mm x 768 mm x 483 mm)

Interface Package: An RS-232 computer interface is available for setting the bath temperature via an external computer. For IEEE-488 add the 2001-IEEE to the interface package.

Ordering Information:

7040 Bath	**$9,200**
2001-7040 Interface Pkg.*	**3,559**
2001-IEEE Add for IEEE	**500**
2010 Spare Lexan Access Cover	**140**
2073 Floor Cart with Casters	**395**

**Automates refrigeration valves and heater controls and accesses digital controller through an RS-232 port.*

LOW-TEMPERATURE BATH — Range: –60°C to 110°C

Low-Temperature Bath	Model 7060
Uses common refrigerants for easy maintenance	
Self-contained system requires no liquid nitrogen	
Complete computer interface available	

If your calibration requirements go as low as –60°C, Hart's new Model 7060 Bath gets you there with greater convenience than other equipment, and you won't need to bother with liquid nitrogen or other external connections.

Manual refrigeration valves give you control over cooling power so it can be balanced against heating power for maximum control stability at your temperature setpoint.

If you order the interface package option, the refrigeration valves can be automatically controlled and reset from your PC, eliminating all manual bath adjustments for totally automated calibration systems.

The same advanced digital control system used in all of Hart's baths gives the 7060 stability up to ±0.001°C. Uniformity exceeds ±0.005°C to handle all your comparison calibrations up to and including calibration of secondary standards.

Specifications — Model 7060

Range: –60°C to 110°C

Stability:

–60°C	±0.003°C
–40°C	±0.002°C
0°C	±0.001°C
25°C	±0.001°C
100°C	±0.003°C

Uniformity: ±0.005°C

Temperature Setting: Digital display with pushbutton data entry

Setpoint Resolution: 0.01°C
High Resolution Mode: 0.00007°C

Display Temp. Resolution: 0.01°C

Digital Setting Accuracy: ±1°C

Digital Setting Repeatability: ±0.01°C

Heaters: 500 and 1000 watts

Access Opening: 5" x 10" (127 mm x 254 mm)

Depth: 12" (304 mm)

Wetted Parts: 304 Stainless Steel

Power: 230 VAC. 50/60 Hz. 22 amps, single phase

Volume: 6.6 gallons (25 liters)

Weight: 350 lbs (159 kg)

Size: 46" H x 32" W x 19" D (1.168 mm x 813 mm x 483 mm) mounted on casters

Interface Package: An RS-232 computer interface is available for setting the bath temperature via an external computer. For IEEE-488 add the 2001-IEEE to the interface package (see page 85).

Ordering Information:

7060 Bath	**$13,995**
2001-7060 Interface Pkg.†	**3,895**
2001-IEEE Add for IEEE	**500**
2010 Spare Lexan Access Cover	**140**

†*Automates refrigeration valves and heater controls and accesses digital controller through an RS-232 port.*

ULTRA LOW-TEMP BATH — Range: –80°C to 110°C

Ultra Low-Temp Bath	Model 7080
Precision cooling power control	
Self-contained dual stage refrigeration	
No liquid nitrogen or external cooling required	

Need to go cold? Say –80°C? If you want a bath with self-contained refrigeration and the finest degree of control in the industry, the Hart Model 7080 is the bath.

It has dual-stage cooling with a unique adjustable refrigeration valve that lets you precisely match the cooling power to the set temperature for maximum bath stability.

Set this bath to any temperature in its range and forget it. It holds its temperature with maximum stability for as long as you need it.

No other low temperature commercial calibration bath has the convenience, stability or uniformity of the Model 7080. Self-contained refrigeration reduces the cost of low temperature calibrations by eliminating the time-consuming problems in working with liquid nitrogen or other external cooling sources.

The bath is mounted on casters for easy movement inside the lab. The entire bath lid assembly is conveniently removable for periodic draining and cleaning of the bath reservoir.

If you need a bath that can run 24 hours a day at any temperature between –80°C and 110°C and hold unbeatable stability, this bath gets the job done.

Specifications — Model 7080

Range: –80°C to 110°C

Stability:

–80°C	±0.003°C
–40°C	±0.002°C
0°C	±0.001°C
25°C	±0.001°C
100°C	±0.003°C

Uniformity: ±0.005°C

Temperature Setting: Digital display with pushbutton data entry

Setpoint Resolution: 0.01°C
High Resolution Mode: 0.00007°C

Display Temp. Resolution: 0.01°C

Digital Setting Accuracy: ±1°C

Digital Setting Repeatability: ±0.01°C

Heaters: 500 and 1000 watts

Cooling Capacity: 125 watts at –80°C, 600 watts at 0°C, dual stage refrigeration. First stage uses R-502 refrigerant, air cooled; second stage uses ethylene as refrigerant with some propane used to help oil flow in low stage.

Access Opening: 5" x 10" (127 mm x 254 mm)

Depth: 12" (304 mm)

Wetted Parts: 304 Stainless Steel

Power: 230 VAC, 50/60 Hz, 22 amps, single phase

Volume: 6.6 gallons (25 liters)

Weight: 350 lbs (159 kg)

Size: 46" H x 32" W x 19" D (1,168 mm x 813 mm x 483 mm) mounted on casters

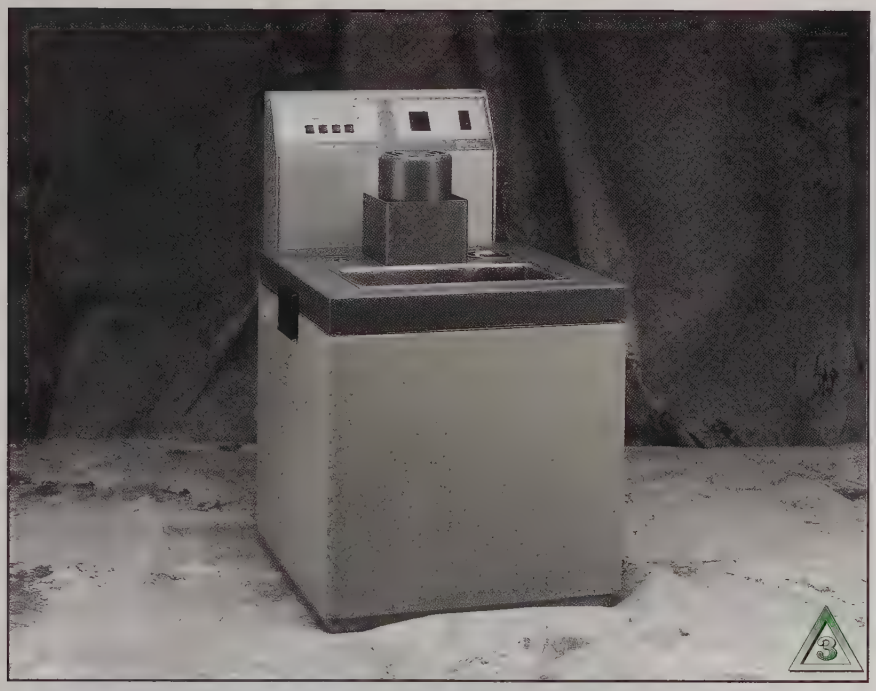
Interface Package: An RS-232 computer interface is available for setting the bath temperature via an external computer. For IEEE-488 add the 2001-IEEE to the interface package (see page 85).

Ordering Information:

7080 Bath	**$15,995**
2001-7080 Interface Pkg.†	**3,895**
2001-IEEE Add for IEEE	**500**
2010 Spare Lexan Access Cover	**140**

†Automates refrigeration valves and heater controls and accesses digital controller through an RS-232 port.

LOW-RANGE OIL BATH — Range: 40°C to 150°C



Low-Range Oil Bath	Model 6010
Maximum value for moderate heated temperatures	
Ideal for thermistor or semiconductor sensor calibrations	
Operate below 40°C with an external chiller and built-in coils	
Use with optional fluid level adapter for glass thermometers	

If you're doing calibrations in the narrow range of 40°C to 150°C, Hart's Model 6010 has performance and price matched to your needs.

This bath is designed for moderate temperatures not economical with oil. Calibration and testing of many thermistors, semiconductors and RTDs are suited to the 6010. When used with the optional fluid level adapter on page 86, this unit is perfect for LIG thermometers.

Depending on the temperature you need, distilled water, glycol and water or low-cost oils work fine in the 6010 and save you considerable fluid costs.

Cooling coils are built into the bottom of the tank floor so you can circulate externally chilled fluids for work below 40°C. The entire line of Hart bath accessories are available for this model including: carts, computer interfaces, large well openings, Lexan access covers and fluid level adapters.

Specifications — Model 6010

Range: 20°C to 150°C
(Bath requires external cooling for operation below 40°C. Cooling coils are built into the bath walls. Tubing ports are accessible at the back of the bath for circulating chilled fluid or shop air to boost cooling.)

Stability:
25°C ±0.001°C
100°C ±0.003°C
150°C ±0.004°C

Temperature Setting: Digital display with pushbutton data entry

Setpoint Resolution: 0.01°C
High Resolution Mode: 0.00018°C

Display Temp. Resolution: 0.01°C

Digital Setting Accuracy: ±1°C

Digital Setting Repeatability: ±0.005°C

Heaters: 500 and 1000 watts

Safety Cutout: Adjustable thermocouple over-temperature control

Access Opening: 5" x 10" (127 mm x 254 mm)

Depth: 12" (304 mm)

Wetted Parts: 304 Stainless Steel

Power: 104 to 126 VAC, 60 Hz, 10 amps (220 to 240 VAC, 50 Hz available, add "-E" to the model number)

Volume: 6.6 gallons (25 liters)

Weight: 80 lbs (36 kg)

Size: 20.5" H x 16.3" W x 15.5" D (520 mm x 414 mm x 394 mm)

Interface Package: An optional RS-232 computer interface is available for setting bath temperature via remote computer. For IEEE-488 add the 2001-IEEE to the interface package (see page 85).

Ordering Information:

6010 Bath	**$5,650**
2001-6010 Interface Pkg.†	**1,549**
2001-IEEE Add for IEEE	**500**
2010 Spare Lexan Access Cover	**140**
2070 Floor Cart with Casters	**395**

†*Automates heater controls and accesses digital controller through an RS-232 port.*

MID-RANGE OIL BATH — Range: 40°C to 300°C

Mid-Range Oil Bath	Model 6020
New range to 300°C	
Two power settings on bath heater for rapid heating	
Built-in cooling coils for cooling fluid circulation	
Portable cart option	

The Hart Model 6020 is an ultra stable bath for work between 20°C and 300°C. It is often selected as the best "oil bath" in many calibration labs. The most commonly used calibration oils provide their best performance in this temperature range.

The bath weighs less than 90 pounds and has a small footprint for benchtop use, or you can choose the portable cart option for greater mobility in the lab.

It is an excellent bath for comparison calibrations of SPRTs and secondary standards where ±0.001°C calibration specs are a routine requirement.

Hart's top-of-the-line stability really pays off when throughput is important and you can't afford the valuable time needed to fiddle with less stable baths.

Every Hart bath now features a newly designed digital bath controller that incorporates the latest in analog and digital electronics for the finest temperature control in the industry.

For additional labor savings and ease of use, automate control of your 6020 with Hart's optional computer interface. Your 6020 can connect to your PC through the optional interface package for computer control of all bath functions.

Specifications — Model 6020

Range: 20°C to 300°C
(Bath requires external cooling for operation below 40°C. Cooling coils are built into the bath walls. Tubing ports are accessible at the back of the bath for circulating chilled fluid or shop air to boost cooling.)

Stability: 25°C ±0.001°C
100°C ±0.003°C
300°C ±0.006°C

Temperature Setting: Digital display with pushbutton data entry

Setpoint Resolution: 0.01°C
High Resolution Mode: 0.00018°C

Display Temp. Resolution: 0.01°C

Digital Setting Accuracy: ±1°C

Digital Setting Repeatability: ±0.02°C

Heaters: 500 and 1000 watts

Safety Cutout: Adjustable thermocouple over-temperature control

Access Opening: 5" x 10" (127 mm x 254 mm)

Depth: 12" (304 mm)

Wetted Parts: 304 Stainless Steel

Power: 104 to 126 VAC, 60 Hz, 10 amps (240 VAC, 50 Hz available, add "-E" to the model number.)

Volume: 6.6 gallons (25 liters)

Weight: 80 lbs (36 kg)

Size: 20.5" H x 16.3" W x 15.5" D (521 mm x 414 mm x 394 mm)

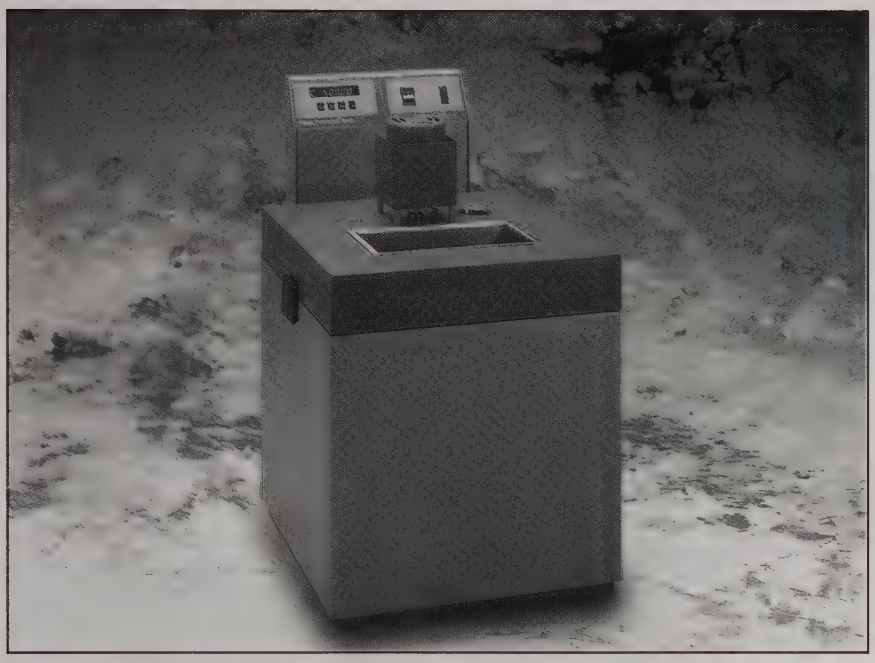
Interface Package: An optional RS-232 computer interface is available for setting bath temperature via remote computer. For IEEE-488 add the 2001-IEEE to the interface package (see page 85).

Ordering Information:

6020 Bath	**$6,250**
2001-6020 Interface Pkg.†	**1,549**
2001-IEEE Add for IEEE	**500**
2007 Spare Stainless Steel Access Cover	**140**
2070 Floor Cart with Casters	**395**

†*Automates heater controls and accesses digital controller through an RS-232 port.*

HIGH-TEMP CALIBRATION BATH — Range: 40°C to 400°C



High-Temp Calibration Bath	Model 6045
No more messy sand baths	
Salts can be used for temperatures between 150°C and 400°C	
Drain for the removal of salts or oils	
Electronically adjustable temperature cutout for probe protection	

For precise calibration of thermocouples and RTDs up to 400°C, Hart manufactures the Model 6045 high Temperature Calibration Bath. The bath is designed for use with salts from 150°C to 400°C and oils from 40°C to 300°C.

The unique design of the Model 6045 insures industry leading stability and maintenance of excellent temperature uniformity. Standard features include a digital microprocessor-based bath controller, adjustable temperature cutouts for probe protection, a special drain plug for removing oils and salts and built-in cooling coils for air or fluid circulation as an aid to rapid cool down or operation below 40°C.

You don't have to deal with messy sand baths or inaccurate furnaces again. The bath is benchtop or cart mountable, and like most Hart baths, the 6045 has a computer interface option for automation of temperature control, including precalibration setup.

Specifications — Model 6045

Range: 20°C to 400°C
(Bath requires external cooling for operation below 40°C. Cooling coils are built into the bath walls. Tubing ports are accessible at the back of the bath for circulating chilled fluid or shop air to boost cooling.)

Stability:

45°C	±0.001°C
100°C	±0.002°C
200°C	±0.003°C
300°C	±0.005°C
400°C	±0.01°C

Temperature Setting: Digital display with pushbutton data entry

Setpoint Resolution: 0.01°C
High Resolution Mode: 0.00018°C

Display Temp. Resolution: 0.01°C

Digital Setting Accuracy: ±1°C

Digital Setting Repeatability: ±0.02°C

Heaters: 350, 1000 and 1700 watts

Safety Cutout: Adjustable over-temperature control

Access Opening: 5" x 10" (127 mm x 254 mm)

Depth: 12" (304 mm)

Wetted Parts: 304 Stainless Steel

Power: 104 to 126 VAC, 50/60 Hz, 16 amps (240 VAC, 50 Hz available, add "-E" to the model number.)

Volume: 6.6 gallons (25 liters)

Weight: 160 lbs (73 kg)

Size: 30" H x 19" W x 21" D (762 mm x 483 mm x 533 mm)

Cart: Recommended for best operation. Bath should not be placed directly on a flammable or heat-damageable surface.

Interface Package: Bath is available with an RS-232 computer interface for setting bath temperature via remote computer. For IEEE-488 add the 2001-IEEE to the interface package (see page 85).

Ordering Information:

6045 Bath	**$7,350**
2001-6045 Interface Pkg.†	**1,769**
2001-IEEE Add for IEEE	**500**
2072 Floor Cart with Casters	**395**
2007 Spare Stainless Steel Access Cover	**140**

†*Automates heater controls and accesses digital controller through an RS-232 port.*

See our selection of bath fluids on page 92.

ULTRA HIGH-TEMP CALIBRATION BATH

Ultra High-Temp Calibration Bath	Model 6050
Microprocessor-based digital bath controller	
Safety shield for operator protection	
Electronically adjustable temperature cutouts	
Over-shoot control for rapid temperature stabilization	

To calibrate thermocouples, RTDs and SPRTs up to 500°C, the Hart Model 6050 is the bath you want. Superior temperature control and uniformity give precise comparisons to the reference standard.

The 6050 features stability to ±0.002°C and the highest temperature range of any salt bath on the market.

The bath also has a perforated safety shield to protect bath operators from hot surfaces, electronically adjustable temperature cutouts for probe protection, a special drain for removing salts and oils, built-in cooling coils for air or fluid circulation as an aid to rapid cool down and overshoot control for fast temperature stabilization.

For high temperature calibrations, no one makes a better instrument. At 500°C, a Hart bath is 10 to 100 times more stable than alternative calibration devices.

Why use messy sand baths that have poor stability? Collapsing the bed in a sand bath for improved stability only increases its gradient problems, making calibration of multiple probes difficult. And the 6050, when used with salts, emits no fumes or alumina dust to mess up your lab.

Each 6050 high temperature calibration bath is insulated with 3 inches of ceramic fiber to minimize heat loss, protect stability and conserve energy. The entire tank of each bath is heated on all four sides and the bottom for uniformity. High temperature, low gradients and superior stability make the 6050 the best in its class of calibration instruments.

Hart's digital microprocessor-based controller is included with every 6050 and can be linked to your PC through its optional interface package.

If you want to go higher in temperature, we offer the 6050H for use to 550°C. Don't forget your floor cart and bath salts.

Specifications	Model 6050

Range:
6050: 20°C to 500°C
6050H: 20°C to 550°C
(Bath operates as low as 20°C but the likely medium in the 6050 is salt, which is limited to 150°C minimum. Cooling coils are built into the bath walls. Tubing ports are accessible at the back of the bath for circulating chilled fluid or shop air to boost cooling.)

Stability: 160°C ±0.002°C
300°C ±0.005°C
500°C ±0.015°C

Temperature Setting: Digital display with pushbutton temperature setting and 0.01°C resolution.

Setpoint Resolution: 0.01°C
High Resolution Mode: 0.00018°C

Display Temp. Resolution: 0.01°C

Digital Setting Accuracy: ±1°C

Digital Setting Repeatability: ±0.02°C

Heaters: 350, 1000 and 1700 watts

Safety Cutout: Adjustable

Access Opening: Up to 5" x 10". Insulated access cover is included with 4" diameter circular opening (127 mm x 254 mm with 102 mm diameter opening)

Depth: 12" (304 mm)

Wetted Parts: 304 Stainless Steel

Power: 104 to 126 VAC, 50/60 Hz, 16 amps (240 VAC available add "-E" to the model number.)

Volume: 6.6 gallons (25 liters)

Weight: 180 lbs (68 kg)

Size: 30" H x 22" W x 24" D (762 mm x 559 mm x 610 mm)

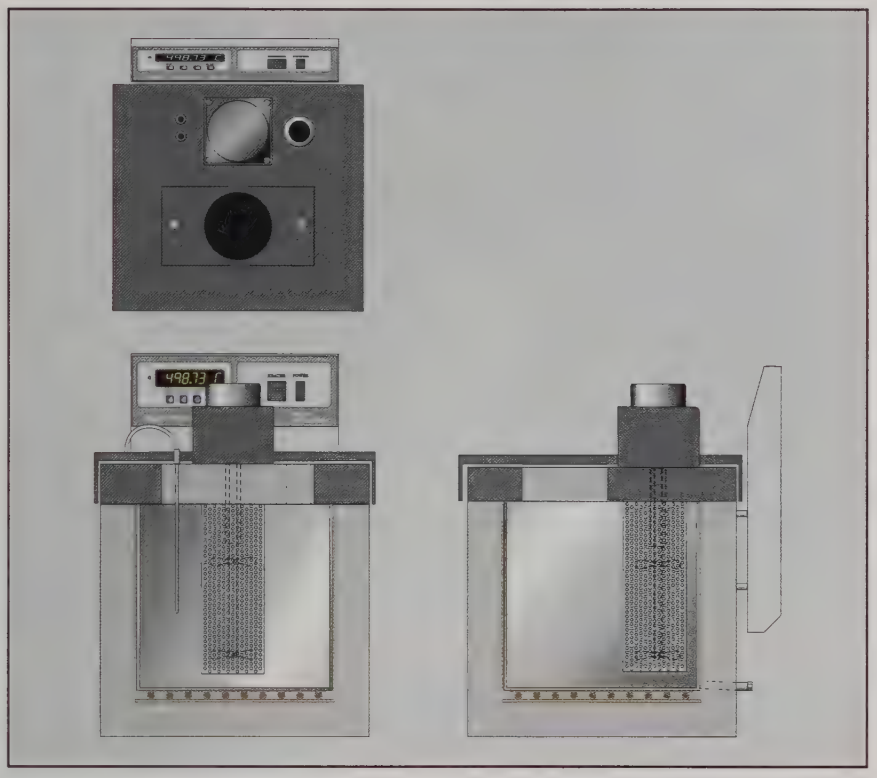
Safety Shield: Perforated metal shield to prevent inadvertent user contact with hot bath surfaces

Cart: Recommended for best operation. Bath should not be placed directly on a flammable or heat damageable surface.

Interface Package: Bath is available with an RS-232 computer interface for setting bath temperature via remote computer. For IEEE-488 add the 2001-IEEE to the interface package (see page 85).

Ordering Information:

6050 Bath, 500°C	**$9,290**
6050H Bath, 550°C	**10,650**
2001-6050 Interface Pkg.	**1,769**
2001-IEEE Add for IEEE	**500**
2072 Floor Cart with Casters	**395**
5001 Bath Salt, 125 lbs	**260**
2014 Spare Access Cover	**290**



Cutaway views of 6050 bath interior showing relationship of components. Note the large unobstructed workspace and new rear control panel.

HART FAST START — Model 2023 & 2024

Do you get impatient waiting for your high temp. bath to reach its set-point temperature? The Hart Fast Start cuts bath heat-up time in half.

Simply insert the dedicated heater into the bath fluid fill hole in the lid of your Hart bath and double your heater power. It's fast, it's easy, and it's convenient. It pays for itself quickly in reduced waiting time.

The heater is a low watt density type, suitable for use in oils and salts. Get greater utilization out of your high temp. bath with the Hart Fast Start.

Specifications

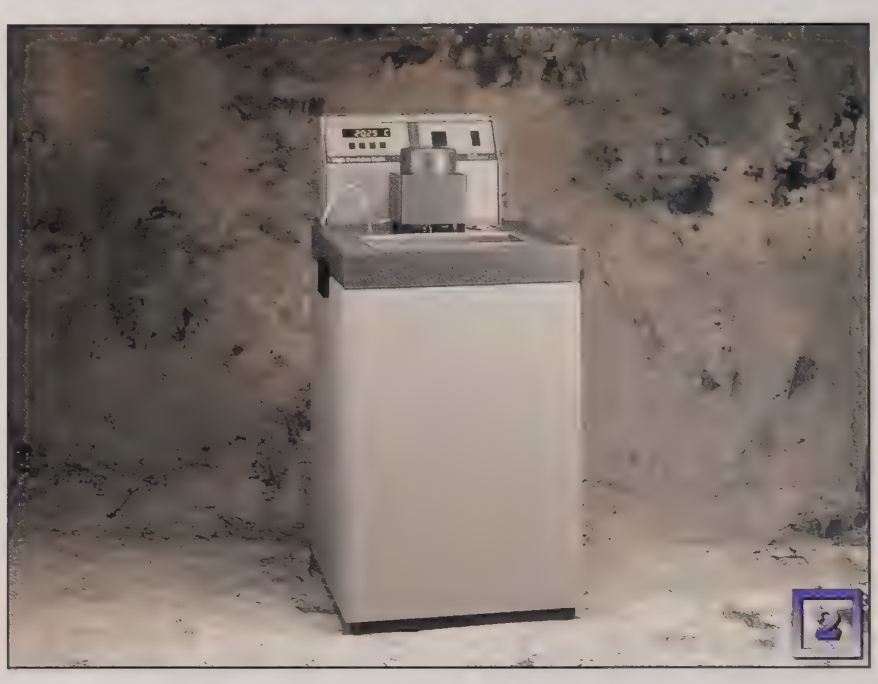
Heater: 1,000 watts, 110 VAC (for 240 VAC add "E" to model number)

Length: 2023 16.5 inches
2024 13.5 inches

Ordering Information:

2023 Fast Start Heater (16.5")	**$800**
2024 Fast Start Heater (13.5")	**800**

DEEP OIL BATH — Range: 40°C to 300°C



Deep Oil Bath	Model 6022
Calibrations up to 300°C	
18 inches deep for long SPRTs	
Optional fluid level adapter	

If your probes are extra long, the Hart Model 6022 gives you the depth you need.

This bath gives you a full 18-inch depth. L.I.G. thermometers or long stem SPRTs are easily calibrated to temperatures up to 300°C. Bath stability is ±0.001°C. The bath fluid is precisely stirred to minimize horizontal and vertical gradients. It has a 5 inch by 10 inch well opening for calibrating multiple probes simultaneously.

Everything about this bath says quality. It is completely automatable through an optional interface package. It uses standard silicone oils. A floor cart and fluid level adapter are also available, and like all Hart baths, it's built to last ten years or more under heavy use.

You can rely on Hart for the products you need. Don't compromise your quality standards with lesser equipment. Given the life expectancy of Hart baths, they're some of the most economical calibration instruments you can buy, and no one matches Hart specs under traditional laboratory operating conditions.

Specifications — Model 6022

Range: 20°C to 300°C
(Bath requires external cooling for operation below 40°C. Cooling coils are built into the bath walls. Tubing ports are accessible at the back of the bath for circulating chilled fluid or shop air to boost cooling.)

Stability: 40°C ±0.001°C
100°C ±0.003°C
300°C ±0.01°C

Temperature Setting: Digital display with pushbutton data entry

Setpoint Resolution: 0.01°C
High Resolution Mode: 0.00018°C

Display Temp. Resolution: 0.01°C

Digital Setting Accuracy: ±1°C

Digital Setting Repeatability: ±0.02°C

Heaters: 350 and 1050 watts

Safety Cutout: Adjustable thermocouple over-temperature control

Access Opening: 5" x 10" (127 mm x 254 mm)

Depth: 18" (457 mm)

Wetted Parts: 304 Stainless Steel

Power: 104 to 126 VAC, 60 Hz, 10 amps (240 VAC, 50 Hz available, add "-E" to the model number.)

Volume: 9.2 gallons (35 liters)

Weight: 70 lbs (33 kg)

Size: 32" H x 19.5" W x 22.5" D (813 mm x 495 mm x 572 mm)

Interface Package: An optional RS-232 computer interface is available for setting bath temperature via remote computer. For IEEE-488 add the 2001-IEEE to the interface package (see page 85).

Ordering Information:

6022 Bath	**$6,750**
2001-6022 Interface Pkg.†	**1,549**
2001-IEEE Add for IEEE	**500**
2010 Lexan Access Cover	**140**
2007 Spare Stainless Steel Access Cover	**140**
2070 Floor Cart with Casters	**395**
2016 Fluid Level Adapter	**1,050**

†*Automates heater controls and accesses digital controller through an RS-232 port.*

SPECIAL RANGE BATH — Range: –30°C to 150°C

Special Range Bath	Model 7030
New fluid level adapter for glass thermometers	
Moderate high and low temperatures in a single bath	
Caster-mounted cabinet for mobility	

The Model 7030 design is excellent for mobile calibration labs where cabinet size and fluid containment are issues.

If you want the maximum versatility possible from a single bath over the temperature range of –30°C to 150°C, or if you're doing calibrations for the military, the Hart Model 7030 is for you.

This bath features the fastest heating and cooling rates available in any commercial bath. You can go from ambient to 150°C in 30 minutes or less. It is designed for customers who want a single unit but have a wide variety of temperature calibration needs.

The cylindrical test well has no stirrers, heaters or coolers inside the well for easy and rapid immersion of probes. The bath has self-contained refrigeration and is equipped with casters for moving about the lab.

For customers who need to calibrate glass thermometers, Hart engineers have designed a fluid level adapter (see page 86) that slides directly into the test well.

The fluid level adapter creates a positive fluid surface that puts the glass thermometer meniscus above the edge of the well for clear viewing. The clear acrylic fluid level adapter cover protects bath fluid from ambient temperature effects for better bath stability.

Customers all over the world rely on Hart calibration products. This bath is a favorite of the U.S. Air Force, the U.S. Navy, Allied Signal and GPU Nuclear.

Specifications — Model 7030

Range: –30°C to 150°C

Stability: ±0.01°C, full range

Temperature Setting: Digital display with pushbutton data entry

Setpoint Resolution: 0.01°C
High Resolution Mode: 0.00018°C

Setting Accuracy: ±0.2°C

Cooling Rate: 25°C to –30°C, 120 min

Heating Rate: 25°C to 150°C, 30 min

Test Well: Constant volume with mercury trap and drain

Test Well Size: 2.6" dia x 11" D (66 mm x 279.4 mm)

Access Opening: 2.6" (66 mm) dia w/Teflon cover

Uniformity: Better than ±0.01°C

Liquid Volume: 1.6 gallons (6 liters)

Refrigeration: Single stage, ¼ Hp R-502 air cooled condenser, 2 cooling settings

Heating: 2 selectable heating powers

Wetted Parts: 304 Stainless Steel

Power: 104 to 126 VAC, 60 Hz, 10 amps (240 VAC, 50 Hz available, add "-E" to the model number.)

Size: 14" W x 17" D x 36" H to bath surface, 40" H to top of stirring motor (356 mm x 432 mm x 914 mm, 1,016 mm)

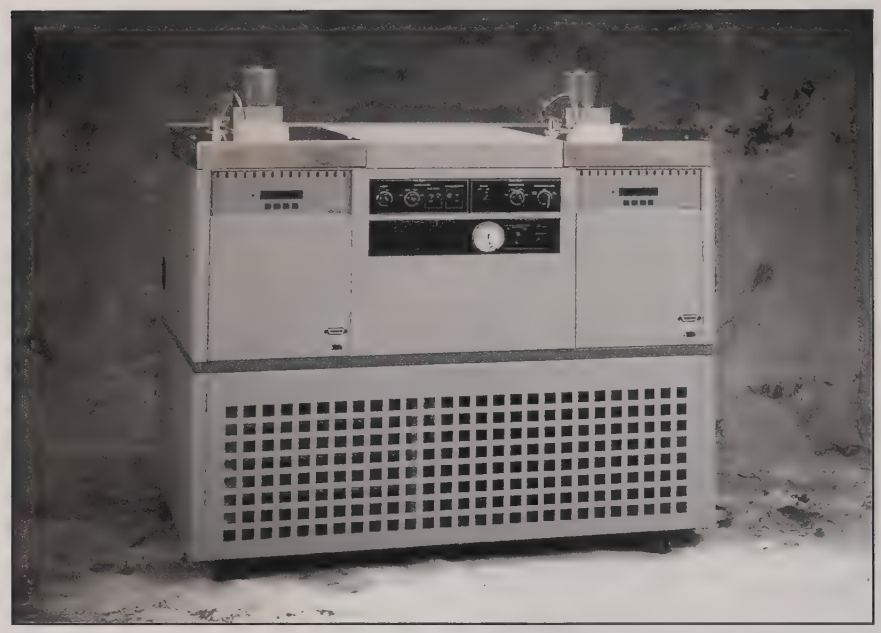
Weight: 120 lbs (54.4 kg)

Ordering Information:

7030 Bath	**$9,995**
2001-7030 Interface Pkg.†	**3,389**
2001-IEEE Add for IEEE	**500**
2019 Fluid Level Adapter	**750**
2017 Spare Access Cover	**130**

†*Automates refrigeration valves and heater controls and accesses digital controller through an RS-232 port.*

DOUBLE-WELL CALIBRATION BATH — Range: –100°C to 300°C



Double-Well Calibration Bath	Model 7013
–100°C without liquid nitrogen	
Double well in one cabinet	
High and low temperature simultaneous calibrations	

If you're looking for a bath that saves labor and covers the broadest calibration temperature range found in precision baths, from –100°C to 300°C, the Hart Model 7013 is the bath for you.

The 7013 features two test wells so that one can be used below ambient and the other above ambient for the simultaneous calibration of different sensors at different temperatures.

The bath is excellent for calibration of thermistors, RTDs, thermocouples, semi-conductor sensors, liquid or gas filled thermometers, bi-metallic thermometers and even cryogenic sensors.

If your temperature needs cover just the –100°C to 70°C range, the Model 7013 can be manufactured with only the cold well installed.

The Model 7013 is the only calibration bath in the world that can reach temperatures of –100°C without using difficult to handle liquid nitrogen.

The 7013 also accommodates Hart's new fluid level adapter for glass thermometer calibrations (see page 86).

Think about it—no other manufacturer in the world can reach –100°C without LN_2, much less match Hart's stability. When you want the best—buy from the best.

Look at that temperature range; look at the uniformity; look at the stability; can anybody else do it the way Hart does it?

Specifications — Model 7013

Range: Cold Well: –100°C to 70°C
Hot Well: 60°C to 300°C

Stability: –100°C to – 40°C ±0.03°C
–40°C to 150°C ±0.01°C
150°C to 300°C ±0.03°C

Temperature Setting: Digital display with pushbutton data entry

Setpoint Resolution: 0.01°C
High Resolution Mode: 0.00018°C

Setting Accuracy: ±0.5°C

Cooling Rate: 25°C to –100°C, 180 min

Heating Rate: 25°C to 300°C, 45 min

Test Wells: 2, constant volume with mercury trap and drain

Test Well Size: 2.6" dia. x 11" D (66 mm x 279 mm)

Access Opening: 2.6" (66 mm) dia. w/Teflon cover

Uniformity: Better than ±0.02°C.

Liquid Volume: 1.6 gallons (6 liters) each well

Refrigeration: Cold well only, 2 mode system: single stage with ¾ Hp compressor, R-502 refrigerant, air cooled; two stage mode utilizes single stage as high stage of cascade system, ¾ Hp compressor using ethylene as refrigerant with some propane used to help oil flow in low stage.

Heating: 4 positions each well: OFF, 250W, 500W and 1,000W

Power: 200 to 240 VAC, single phase, 60 Hz. Compressors require 230 VAC nominal.

Size: 45.25" W x 26.25" D x 39" H to bath surface, 45" H to top of stirring motors

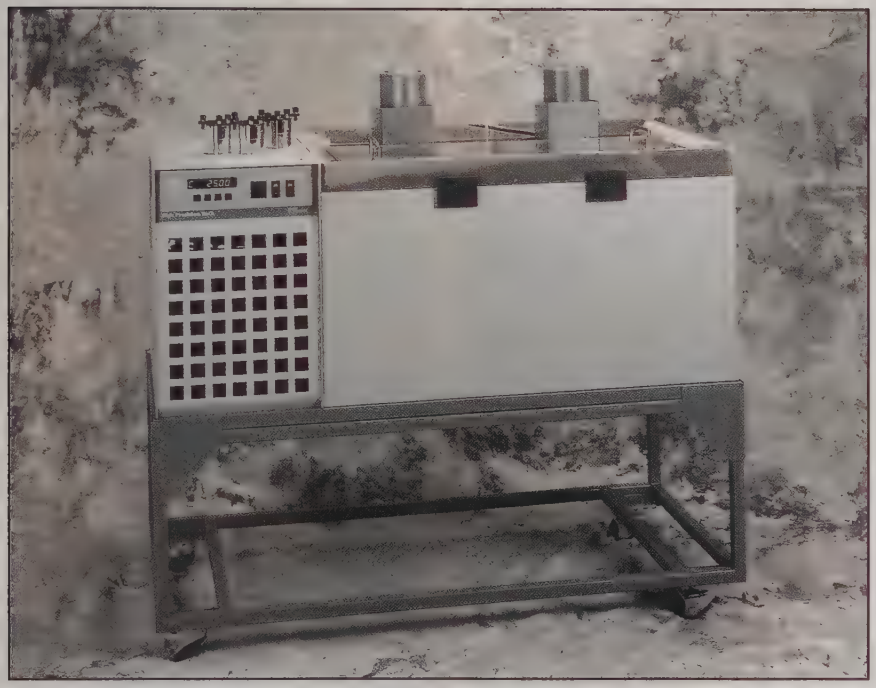
Shipping Weight: 600 lbs

Ordering Information:

7013 Bath	**$29,900**
2001-7013 Interface Pkg.†	**3,895**
2001-IEEE Add for IEEE	**800**
2019 Fluid Level Adapter	**750**
2017 Spare Access Cover	**130**

†*Automates refrigeration valves and heater controls and accesses digital controller through an RS-232 port.*

STANDARD RESISTOR BATH — Model 7015



Standard Resistor Bath	Model 7015
Ultra stability and uniformity	
Large access and workspace	
Electronically isolated	
Affordably priced	

Hart manufactures the broadest range of liquid baths for temperature calibration found in the industry. Each year we add new baths to our line in response to customer requests, and this year we're introducing the Model 7015 designed specifically for the maintenance of standard resistors.

Like all Hart baths, the 7015 has unmatched stability and uniformity. No other bath limits long-term and short-term drift, gradients and other uniformity issues better than this one. Place your standards resistors in the bath where you like and don't worry about resistor performance being influenced by temperature fluctuations.

The 7015 has a one-piece stainless steel lid designed to drain spills and splashes back into the bath when removing resistors, and it's non-corrosive with a large access opening for easy handling of resistors, even the Thomas Design Standards resistors. Inside the tank there's an electrically isolated resistor shelf allowing for continuous flow of fluids around the entire resistor and stirrer guards eliminate wire entanglement and contact with the mixing rods.

This bath is built right, priced right and serviced right. Go ahead—compare it to everything and anything on the market. We did before we designed it and again after we built it.

If this is your first Hart bath we guarantee you'll love this one so much you'll buy other Hart baths, and if you already own other Hart baths, you know why you want this one. Call us, we'd love to talk to you!

Specifications

Range: 0°C to 110°C

Uniformity: ±0.0015°C

Stability: 25°C ±0.0005°C

Temperature Setting: Digital display with pushbutton data entry

Setpoint Resolution: 0.002°C, High Resolution Mode: 0.00003°C

Display Temp. Resolution: 0.01°C

Digital Setting Accuracy: ±1°C

Digital Setting Repeatability: ±0.01°C

Heaters: 500 and 1000 watts

Cooling Capacity: 100 to 200 watts

Access Opening: 27.5" x 11" (699 mm x 305 mm)

Depth: 13.25" (279 mm)

Wetted Parts: 304 Stainless Steel

Power: 104 to 126 VAC, 60 Hz, 15 amps (240 VAC, 50 Hz available, add "-E" to the model number.)

Volume: 25 gallons (95 liters)

Weight: 310 lbs (140.9 kg)

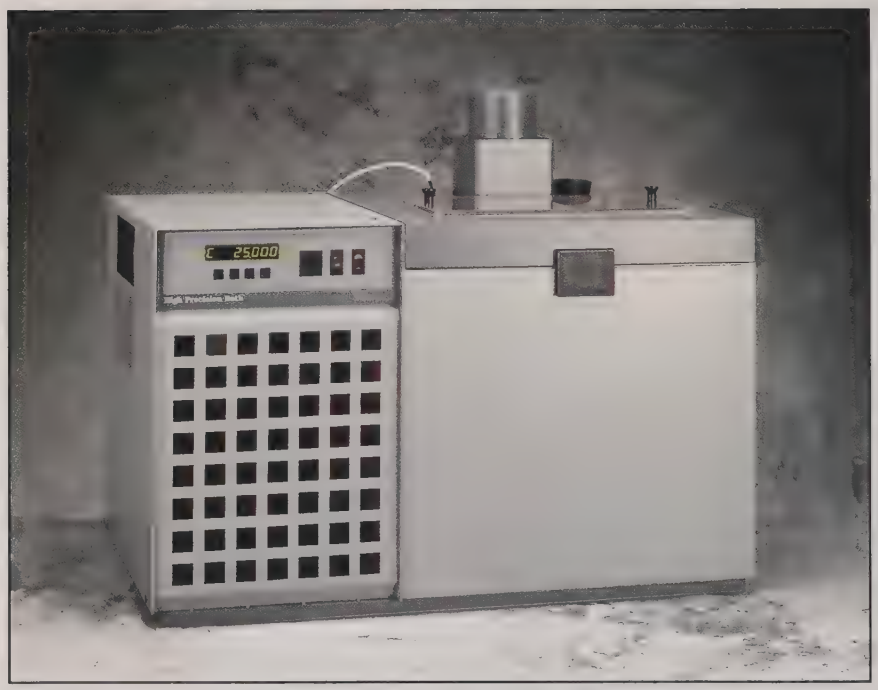
Size: 48" H x 45" W x 20" D (1219 mm x 1143 mm x 508 mm)

Interface Package: An RS-232 computer interface is available for setting bath temperature via an external computer. For IEEE-488 add the 2001-IEEE to the interface package (see page 85).

Ordering Information:

7015 Standard Resistor Bath	**$12,595**
2001-7015 Interface Package	**3,559**
2001-IEEE Add for IEEE	**800**

44 LITER REFRIGERATED BATH — Range: –10°C to 110°C



44 Liter Refrigerated Bath	Model 7008
44 liter capacity	
92 square inch access opening	
Computer controllable	
±0.0005°C stability	

Need a high capacity bath for precision calibrations below ambient temperatures? The same technology found in Hart's most popular bath, the Model 7011, is now available in the 44 liter Model 7008 (–10°C to 110°C).

Bath stability to ±0.0005°C is only one feature of the 7008. It also has built-in refrigeration for reaching cold temperatures without liquid nitrogen or other time-consuming, difficult-to-use coolants. Its 44-liter size handles simultaneous calibrations of multiple probes for sensor throughput.

In addition to sensor calibrations, the Model 7008 has the capacity to handle immersion testing of pressure transducers, production testing of temperature-sensitive level controls, or semiconductor parts in powered fixtures. Well dimensions are 12.75 inches x 7.25 inches—more than 92 square inches of access space.

Automate the 7008 with its optional computer interface. Computer controlled refrigeration valves and heater adjustments automatically balance refrigeration and heater settings for optimum control stability. (See page 84 for an explanation of bath automation, especially for refrigerated models.)

Add the optional lifetime warranted floor cart for mobility and positioning of the 7008 at a convenient work height.

This 44-liter unit is another example of Hart's commitment to calibration at its best.

Specifications — Model 7008

Range: –10°C to 110°C

Uniformity: ±0.001°C

Stability: 0°C ±0.001°C
25°C ±0.0005°C
100°C ±0.001°C

Temperature Setting: Digital display with pushbutton data entry

Setpoint Resolution: 0.002°C, High Resolution Mode: 0.00003°C

Display Temp. Resolution: 0.01°C

Digital Setting Accuracy: ±1°C

Digital Setting Repeatability: ±0.005°C

Heaters: 500 and 1000 watts

Cooling Capacity: 100 to 200 watts

Access Opening: 12.75" x 7.25" (324 mm x 184 mm)

Depth: 13.25" (337 mm)

Wetted Parts: 304 Stainless Steel

Power: 104 to 126 VAC, 60 Hz, 15 amps (240 VAC, 50 Hz available, add "-E" to the model number.)

Volume: 11.6 gallons (44 liters)

Weight: 110 lbs (49.9 kg)

Size: 19" H x 30.5" W x 18.5" D (483 mm x 775 mm x 470 mm)

Interface Package: An RS-232 computer interface is available for setting bath temperature via an external computer (see page 85).

Ordering Information:

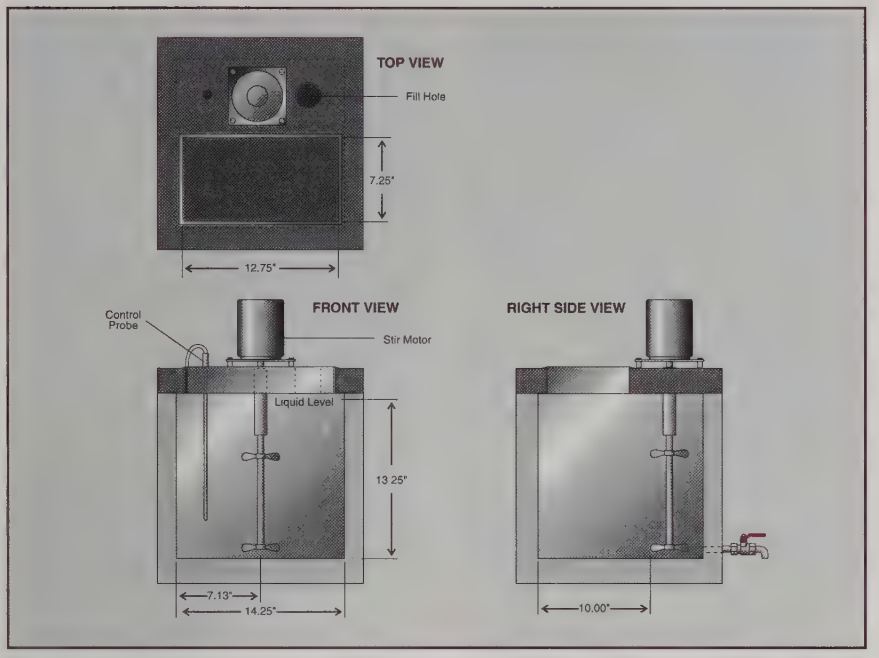
7008 Bath	**$7,895**
2001-7008 Interface Package	**3,389**
2001-IEEE Add for IEEE	**500**
2073 Floor Cart with Casters	**395**

See our selection of bath fluids on page 92.

44 LITER BATHS

If simultaneous calibration of multiple probes is a part of your calibration operation, Hart manufactures a complete line of high capacity baths featuring deep wells (13.25") and large access openings (12.75" x 7.25"). All four baths in Hart's 44 Liter line have the same industry leading specs, including maximum stability, as the other professional Hart calibration baths featured in this catalog.

In addition to multiple probe calibrations, these baths have the size and capacity to handle immersion testing of pressure transducers as well as large oceanographic transducers and production testing of temperature sensitive level controls and semiconductor parts in powered fixtures. If you have testing or calibration needs that exceed the size or temperature ranges in this line, don't forget to check Hart custom baths on page 88.

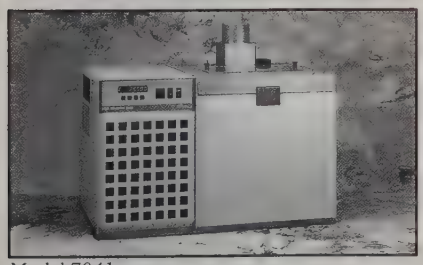


Cross section of 44 liter bath interior with prop guard removed. Dimensions in inches are common to all models.

Model 6024

Model 6024 — 20°C to 300°C

This is a non-refrigerated bath often used with silicone oils for calibrations up to 300°C. It has built-in cooling coils for circulation of fluids for work below ambient. The bath has an adjustable digital over-temp. safety control.



Model 7041

Model 7041 — –40°C to 110°C

The Hart Model 7041 reaches the lowest temperatures possible with a single stage refrigeration system. The bath features user adjustable valving for maximum stability at the coldest temperatures.

Model 7081/7061

Model 7081/7061 –80/–60°C to 110°C

No other commercial calibration bath is available with the combination of self-contained refrigeration for temperatures to –80°C (–60°C for 7061) and the large capacity of the Model 7081. Its cost-benefit ratio is absolutely unbeatable in the industry today!

Ordering Information:

6024 Bath	**$ 6,950**
7041 Bath	**10,200**
7061 Bath	**14,295**
7081 Bath	**16,295**
2011 Lexan Access Cover	**155**
2007 S.S. Access Cover	**140**
2072 Cart for 6024	**395**
2073 Cart for 7041	**395**

See page 85 for computer interface information.

Read the article "Considering an Automated System" on page 84.

DEEP-WELL CALIBRATION BATHS

Refrigerated Deep Well Bath	Model 7007
24" deep bath	
Good surface visibility	
High stability and low gradients	

Specifications Model 7007

Range: –5°C to 110°C

Stability: ±0.001°C typical

Gradients: Less than 0.005°C

Temperature Setting: Digital display with pushbutton data entry

Working Area: 9" dia

Depth: 24" deep, 9" dia., removable Polycarbonate cover

Fluid Level: Can be user maintained at .25" below bath surface to facilitate calibration of glass thermometers

Refrigeration: Built-in single stage compressor, user adjustable

Dimensions: 18.5" D x 30.5" W x 47" to working surface, 55" to top of stir motor, 36" high to control panel

Stand: Integral stand with floor levelers

Liquid Volume: 43 liters (11.5 gal)

Mid Range Deep Well Bath	Model 6054
24" deep bath	
Temperature up to 320°C	
Constant liquid level design	

Specifications Model 6054

Range: 50°C to 320°C

Stability: ±0.005°C typical

Gradients: Less than 0.05°C

Temperature Setting: Digital display with pushbutton data entry

Working Area: 7.5" dia

Depth: 24" deep, 7.5" dia., removable S.S. lid, special viewing channel to allow glass thermometer sighting

Fluid Level: Circulation system maintains constant fluid surface level.

Safety Cutout: Adjustable thermocouple type cutout

Dimensions: 23" D x 31" W x 48" to working surface, 56" to top of stir motor box, 36" to control panel

Stand: Integral stand with floor levelers

Liquid Volume: 50 liters (13.5 gal)

Hi-Temp Deep Well Bath	Model 6055
17" deep bath	
Temperature up to 550°C	
Constant liquid level design	

Specifications Model 6055

Range: 150°C to 550°C

Stability: ±0.005°C typical

Gradients: Less than 0.05°C

Temperature Setting: Digital display with pushbutton data entry

Working Area: 3.8" dia

Depth: 17" deep, 6" dia., removable S.S. lid, special viewing channel to allow glass thermometer sighting

Fluid Level: Circulation system maintains constant fluid surface level

Safety Cutout: Adjustable thermocouple type cutout

Dimensions: 23" D x 30.5" W x 48" to working surface, 60" to top of stir motor box, 36" to control panel

Stand: Integral stand with floor levelers

Liquid Volume: 20.5 liters (5.5 gal)

Range: –5°C to 110°C, 50°C to 325°C and 150°C to 550°C

The Hart Models 7007 and 6055 are designed for liquid-in-glass thermometer calibrations, SPRT calibrations or other thermometry work requiring greater depth.

Both baths have extra deep wells (from 17 to 24 inches deep) to eliminate the stem effect encountered in calibration of probes longer than 12 inches. Originally engineered for a national standards lab, these baths are optimized for the visual calibration of liquid-in-glass thermometers.

The 7007 is designed for the temperature range of –5°C to 110°C, has built-in refrigeration and is 24 inches deep. The 6055 is engineered for the temperature range of 150°C to 550°C and is 17 inches deep. Specific size differences and various specifications are shown under the Specifications section.

In addition, the Model 6055 (to 550°C) uses molten salts with a constant-level pumping system for maintaining the necessary consistent fluid level for liquid-in-glass thermometer calibrations. A viewing channel is built into the insulated bath lid for a clear visual path to the meniscus of glass thermometers.

The 6055 also has the optional thermometer carousel for holding several glass thermometers in the correct calibration position without exposing the glass thermometers to the hot salts in the bath—thus preventing possible devitrification. The Hart Model 2018 carousel uses a non-asbestos high quality refractory material for the drilled top and has an elevated handle for rotating your thermometers to the viewing position.

Both of these baths can handle comparison calibrations of SPRTs or any other sensor calibrations you would normally do in a precision calibration bath.

The 7007 and 6055 use Hart's digital temperature control for greater operational convenience and improved setpoint performance. An RS-232 computer interface option for automated calibration systems is available for either bath.

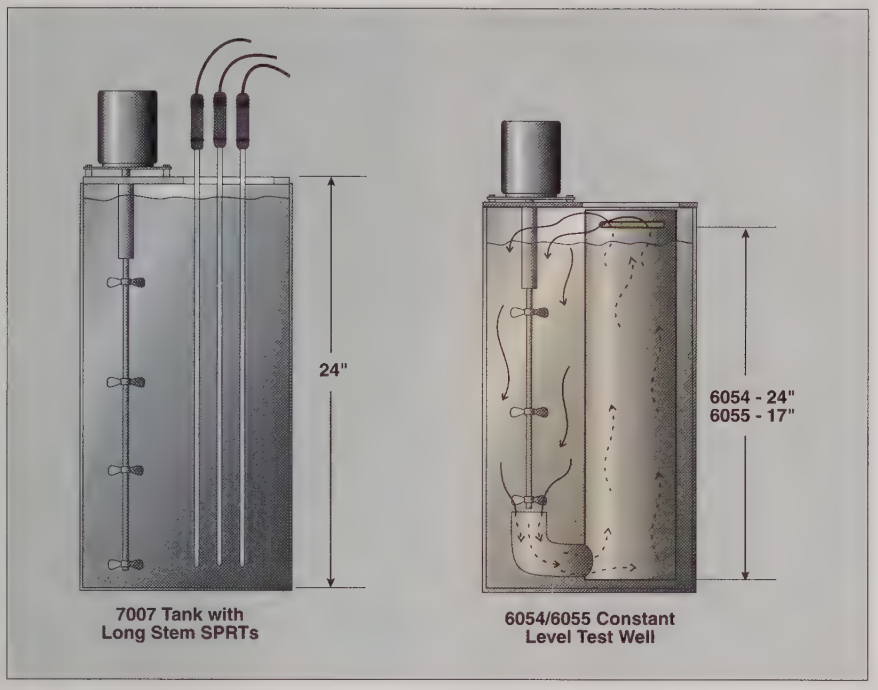
These units are sound economic alternatives to having several special purpose baths in the lab.

While these models have become standard calibration instruments in the Hart line, they serve as excellent examples of how Hart designs baths for custom needs using Hart's proprietary bath technology.

Recently Hart added another deep-well bath to its line. The Model 6054 operates between 50°C and 325°C for use with silicone oils. It has a 24-inch depth, a working area of 7.5 inches in diameter and a constant fluid surface for obtaining the best glass thermometer calibration readings.

With the exception of its temperature range and working area, it has the same fine operating specs as the Model 7007 and 6055, including the ±0.005°C stability described on the previous page.

If you have calibration requirements that go beyond the traditional, see page 88 for more information on how we can solve your calibration problems.



Extra deep tanks for long-stem SPRTs and pumped fluid level control are important features in the Deep Well Calibration Bath line.

Ordering Information:

7007 Refrig. Deep Well	**$13,600**
6054 Mid Range Deep Well	**14,300**
6055 Hi-Temp Deep Well	**14,600**
2001-7007 Interface Package	**3,559**
2001-6054 Interface Package	**2,190**
2001-6055 Interface Package	**2,190**
2001-IEEE Add for IEEE	**500**
2018 Carousel Holding Fixture for 6055	**2,100**

CONSIDERING AN AUTOMATED SYSTEM

The calibration of temperature sensors is a labor intensive task. A technician must set and adjust the bath temperature, immerse the sensors in the bath and manually compare each sensor reading against a reading from a standard or reference thermometer.

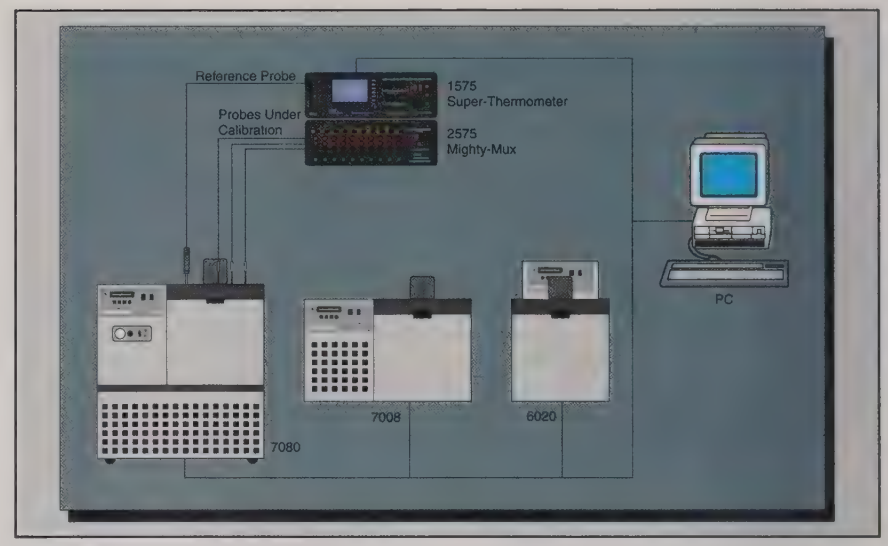
For a complete calibration of each sensor, most applications require checking three to ten temperature points, a time consuming and expensive process.

Many calibration labs are setting up automated systems both to save money and to increase equipment utilization. Computer-aided automation can do all the following automatically and unattended:

1. Set the bath temperature.
2. Read and record sensor temperature.
3. Read and record the temperature of the reference thermometer.
4. Compare the readings.
5. Change the bath temperature.
6. Repeat the measurements.
7. Print the calibration reports and certificates, automatically formatted according to application requirements.

Automation eliminates the manual bath-temperature adjustments normally required to calibrate a sensor across several check points. While the computer technology necessary for automation is widely available, not all baths with a computer interface are capable of the precision and stability necessary for maintaining calibration accuracy under automated control.

Automated calibration is most effectively used to calibrate multiple sensors simultaneously. In this situation, uniformity of temperature throughout the test zone of the bath is critical; the temperature of the liquid surrounding the reference sensor must be the same as the temperature of the liquid surrounding each sensor being tested. Any temperature gradients that exist will contribute to error in calibration.



Automated RTD Calibration System.

In addition to uniformity, short-term control stability is also important: the bath temperature must remain constant while all sensors in the bath are checked at each calibration point.

Refrigerated baths for below-ambient applications require more sophisticated controls than are found on high-temperature baths. A simple on-off control of the refrigeration is insufficient to adjust cooling power because more cooling power is necessary at low temperatures (such as −65°C), and less cooling power is necessary at higher temperatures (such as 0°C). Unless cooling power is adjusted at higher temperatures, the excess cooling will be out of balance with the heater power, making it impossible to achieve high stability.

To achieve fully automated control of refrigerated baths, cooling power must be controllable by a computer. Therefore, the bath interface must include a mechanism for the balancing of the refrigeration system.

The best mechanism for balancing cooling power is electronically controlled refrigeration valves. While this valving is expensive, it allows for precision bath control. Other manufacturers don't provide any computer controllable valves. They use a more primitive, less accurate on-off control.

The cost of an automated bath and calibration system often is lower than the cost of a manual system when throughput and productivity are considered.

In a good automated system, a calibration technician simply connects the sensors, starts the calibration program, moves on to another project, and then returns after a few hours to collect the printed calibration reports and connect a new batch of sensors. Manpower savings are considerable.

Since the use of computer-controlled calibration is increasing, it is best to buy equipment that has the correct computer interface capabilities installed and performs at specs adequate for calibration under automation.

While the initial purchase price of the proper equipment may be slightly higher, overall calibration costs during the long life of a bath will be substantially lower. Further, the equipment will remain compatible with advances in calibration automation systems.

BATH/COMPUTER INTERFACES

For automated calibration systems, Hart offers microprocessor-based interface packages for computer control of your Hart baths.

Using a Hart interface, your PC can move your calibration bath through several setpoints without sacrificing stability or accuracy. Each interface is designed specifically for the bath it is controlling. Computer control of temperature setpoints, heater settings, and refrigeration settings are provided by the interface option.

In addition, each interface provides digital temperature feedback to your PC, so you can see both the bath setpoint and actual temperature on your computer screen. Safety cutout temperatures are electronically set.

Connection to your PC is accomplished through the RS-232 port on the back of the computer. IEEE-488 interface is also available.

For a traceable temperature reading in your system, use Hart's model 1506 or the 1575 Super-Thermometer. Both are available with RS-232 or IEEE interfaces.

Be sure to read the catalog article "Considering an Automated System" on the previous page for more information on the benefits of computer control.

Ordering Information:

All bath interfaces must be ordered at the time of bath purchase. They are not retrofitable. Each interface is built into and fully integrated with the electronic circuitry of the calibration bath ordered.

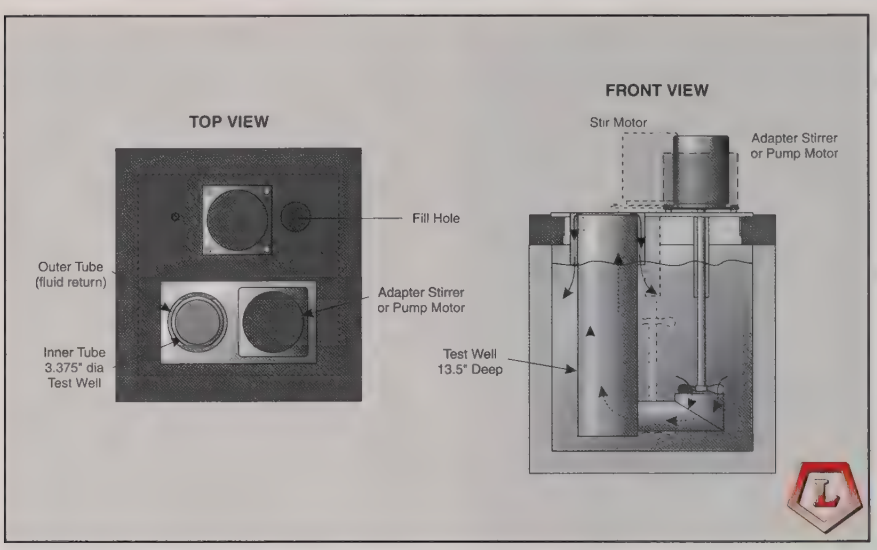
To order the standard RS-232 interface package, simply add the listed line item separately from the bath on your purchase order. If you want to order an IEEE-488 interface, use the listed interface package part number and price and then add the IEEE part number and price as a separate line item.

2001-6010 Interface Pkg.	**$1,549**
2001-6020 Interface Pkg.	**1,549**
2001-6022 Interface Pkg.	**1,549**
2001-6024 Interface Pkg.	**1,549**
2001-6025 Interface Pkg.	**645**
2001-6035 Interface Pkg.	**645**
2001-6045 Interface Pkg.	**1,769**
2001-6050 Interface Pkg.	**1,769**
2001-6054 Interface Pkg.	**2,190**
2001-6055 Interface Pkg.	**2,190**
2001-7007 Interface Pkg.	**3,559**
2001-7008 Interface Pkg.	**3,389**
2001-7013 Interface Pkg.	**3,895**
2001-7015 Interface Pkg	**3,559**
2001-7025 Interface Pkg.	**795**
2001-7030 Interface Pkg.	**3,389**
2001-7037 Interface Pkg.	**3,559**
2001-7040 Interface Pkg.	**3,559**
2001-7041 Interface Pkg.	**3,559**
2001-7060 Interface Pkg.	**3,895**
2001-7061 Interface Pkg.	**3,895**
2001-7080 Interface Pkg.	**3,895**
2001-7081 Interface Pkg.	**3,895**

2001-IEEE Add for IEEE	**$500***

*plus the interface package cost as shown above.

FLUID LEVEL ADAPTER — Model 2016



Fluid Level Adapter	Models 2016
Lifetime warranty	
Tough, durable construction	
Fits all Hart 25 and 44 liter bath models	

Add this new accessory to your Hart bath to improve its capability to calibrate glass thermometers. This fluid level adapter fits in the access opening of your bath. It includes a pump and a cylindrical test well. Bath fluid is pumped up through the test well to a level just below the surface of the bath lid, giving you a clear sighting of the mercury column in your thermometer.

The diameter of the test well is 3.5". The adapter can be placed in your bath or removed at will with no complex installation assembly—simply plug it in.

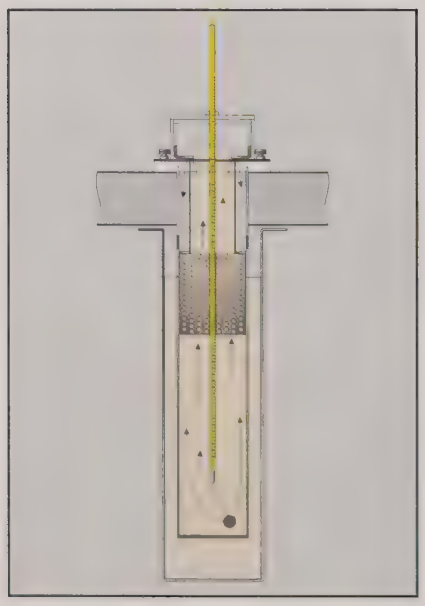
The world's best baths for sensor calibrations are now the world's best baths for glass thermometer calibrations as well. If you're required to service glass thermometers, add this accessory to your bath purchase or to the Hart bath already in your lab.

Ordering Information:

2016-____ Fluid Level Adapter	**$1,050**

To order the correct adapter, enter your bath model no. in the blank area (ie., 2016-7008).

FLUID LEVEL ADAPTER — Model 2019



For customers needing to calibrate glass thermometers, Hart engineers have designed a fluid level adapter that slides directly into the test wells of the 7030 and 7013 calibration baths.

The fluid level adapter creates a positive bath fluid surface. The bath fluid in the test well is pumped up to the surface of the bath and kept there. This puts the glass thermometer meniscus above the edge of the bath test well for clear viewing during calibration.

The clear acrylic adapter cover protects the bath fluid from ambient temperature effects for better bath stability. The cover can be drilled for any size probe.

The adapter is easily pulled from the bath test well to allow more room during calibration of other thermometers and sensors.

Ordering Information:

2019-7030 Fluid Level Adapter	**$750**
2019-7013 Fluid Level Adapter	**750**

BENCHTOP TEMPERATURE CONTROLLER — Model 2100

Hart has combined its fine analog control technology with digital electronics to give you the best controller found on any calibration bath. If you want to get this control technology for use in other applications, try our Model 2100.

With the controller, you can set the temperature setpoint and temperature safety cutouts through the front panel buttons. Along with the front panel control, the Model 2100 has an optional RS-232 for connecting to your PC.

Setpoint resolution is 0.002°C with a thermistor probe and 0.01°C with a platinum RTD. Actual temperature display resolution is 0.01°C. Select degrees C or F from the front panel.

Order either an RTD or thermistor model, depending on the accuracy and stability you need. Either probe choice can be system calibrated for better display accuracy. System accuracy of ±0.1°C is possible with the RTD model and ±0.5°C with the thermistor. If you would like, Hart technicians will perform this calibration for you.

Use your own RTD by simply entering the R_0 and Alpha values of the probe. The thermistor controller requires the Hart Model 2611 thermistor probe.

Many customers use the Hart 2100 to improve control performance in baths or furnaces made by other companies. Some customers use it with their own equipment designs in research and other unique applications. No panel-mounted OEM controller comes close to the 2100's stability specs.

Specifications — Model 2100

Range: –100°C to 650°C

Sensors: Thermistor or RTD

Control Stability: (in a properly designed system) ±0.001°C typical, ±0.0005°C depending on system

System Accuracy with Probes Shown Below:

Thermistor: ±1.0°C

RTD: ±1.0°C

Output: 110 VAC, 10 amps, solid-state relay

Dimensions: 3.38" H x 8.38" W x 11" D (86 mm x 213 mm x 279 mm)

Probes:

2611: Thermistor, 9" long x .218" dia (229 mm x 5.5 mm), –10°C to 110°C

5616: RTD, 10" long x .187" dia (254 mm x 4.7 mm), –100°C to 600°C

5635: Type K thermocouple, 12" long x .187" dia (305 mm x 4.7 mm), 1200°C (for cutout)

Ordering Information:

2100 Controller	**$1,795**
2611 Thermistor Probe	**265**
5616 RTD Probe	**375**
5635 Thermocouple Probe	**60**
2122 RS-232 Interface	**295**
2125 IEEE-488 Interface	**395**

(for 240 VAC power option add "-E" to 2100)

HART CUSTOM BATHS

A national standards lab asked us to modify a standard bath design to incorporate a conical black body target for high precision calibration of optical thermometers.

This bath is used to calibrate large oceanographic sensors. It's one of our largest models and it resists sea water corrosion too.

Another Hart customer required a custom bath with a large window for viewing the devices tested in the bath.

Our line of high stability professional quality temperature calibration baths is the best in the industry and covers a broad base of calibration applications. However, some of our customers require special non-commercially available instruments to solve calibration problems unique to their industry. Hart Scientific offers a full range of custom bath design and manufacturing services.

If you have a problem, we can solve it. If you need a bath with unusual well capacity for large sensors, transducers or other electronic equipment, we can build it. If your company has automated its production process, and you can't take the sensors off the line to calibrate them, how about a high stability precision bath 8 feet long?

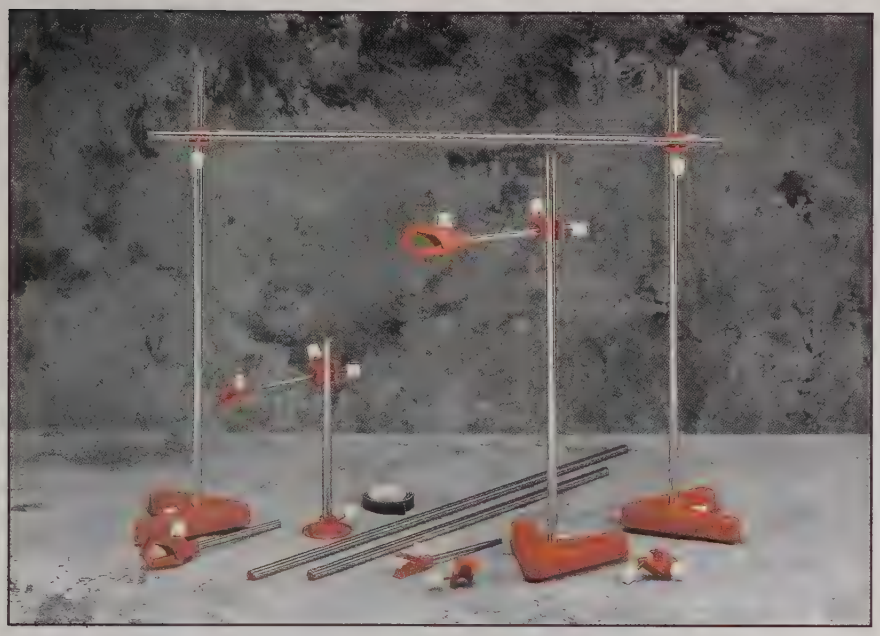
If your temperature demands aren't within our standard line of products, give us a call and let's discuss how Hart can give you exactly what you need.

We can solve depth problems, visibility problems, corrosion issues, constant surface temperature needs, portability and mobility problems—and just about anything else you can think of including:

- Custom tank sizes
- Different temperature ranges
- Viewing windows
- Constant liquid level systems
- Custom access openings
- Custom depth for extra long probes

Fax us a description of what you need—801-785-7118, or call us at 1-800-438-4278.

No, this is not a custom bath. It's Wayne eating part of this year's catalog cover. See page 146 for the whole ugly story.



Mechanical Support for Probes

When setting up a new calibration bath, you have to find a way to suspend your probes in the bath fluid. We recommend our new modular mechanical support systems. Made of only the finest quality steel and machined parts, these support components combine in hundreds of ways to solve almost any probe suspension problem.

Our single probe kit is a good way to get started. It has one medium clamp, one 10-inch rod, one bosshead and one V-base for holding one probe. Excellent for Hart's 9125 Surface Dry-Well.

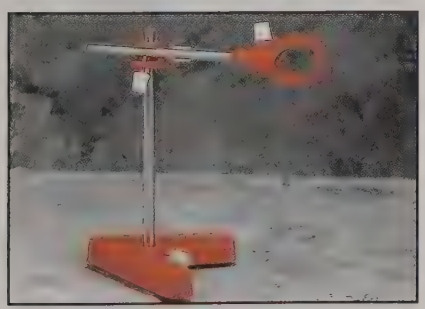
#2051 Single Probe Kit **$95**

Our economy kit includes 2 V-bases, one 29" stainless steel rod, two 23" rods, 5 bossheads, 2 micro-clamps and 1 medium clamp. This will build a bench mounted frame for suspending 1 rod and 3 clamps over a bath opening. Simply add to your setup as needed. Choose from any of the listed accessories.

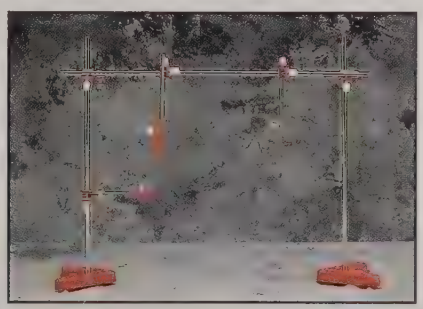
#2050 Economy Kit **$230**

Individual Hardware

Our selection of clamps and stands provides a simple way to hold probes and thermometers in baths during calibration. System components can be assembled in a number of ways to suit individual needs. Select clamps, rods, bossheads and base(s).



Single Probe Kit.



Economy Kit.

Micro-Clamp

Holds thermometers and probes with diameters to 0.75 inch.

#2055 (Pkg. of 2) **$37**

Medium Clamp

Holds diameters up to 1.75 inches.

#2056 (Pkg. of 1) **$40**

Non-Slip Tape

Increases grip on clamps and bossheads.

#2057 1 roll **$14**

Stainless Steel Rods

Used to assemble supports, frameworks or scaffolds.

#2058 10" (Pkg. of 1) **$16**
#2059 20" (Pkg. of 1) **$25**
#2060 23" (Pkg. of 1) **$45**
#2061 29" (Pkg. of 1) **$36**

Bosshead

Clamps 2 rods at right angles. Also attaches clamps to rods.

#2062 (Pkg. of 5) **$26**

Screw Base

Holds one rod and is screwed to the surface of your bench or bath lid. 2.5-inch dia. Screws included.

#2063 (Pkg. of 4) **$32**

V-Base

Holds one rod. Weighted for excellent stability. 2.2 lbs (1 kg)

#2064 (Pkg. of 1) **$40**

Large V-Base

Same as above but larger. Recommended for holding SPRTs and large probes. 4.4 lbs (2 kg)

#2065 (Pkg of 1) **$45**

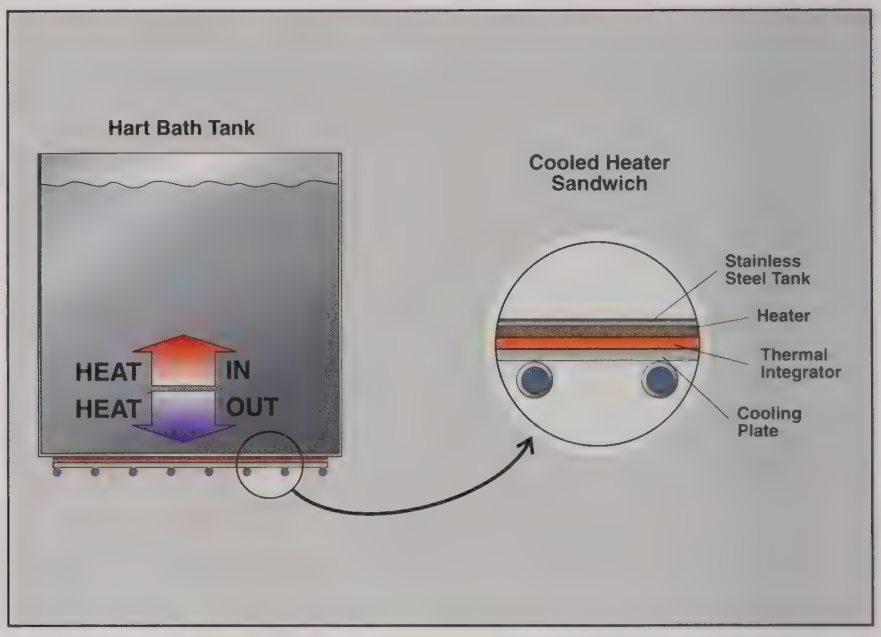
UNDERSTANDING STABILITY

Stability is an important measure of a calibration bath's performance. Poor bath stability negatively affects calibration in several meaningful ways.

Valuable time is lost fiddling with low stability instruments that constantly move in and out of acceptable calibration temperature ranges. Users have to adjust and readjust the instruments to get adequate performance and control drift.

The more stable an instrument, the more certainty that serially-calibrated sensors are within the specified calibration tolerance. Serially-calibrated sensors are more uniformly matched in their temperature measuring capabilities.

Hart Scientific's temperature calibration equipment reaches levels of stability that no other manufacturer can match. We're often asked how we do it. The answers are not mysterious. It is all accomplished with prudent, well-understood technology and quality construction.



Hart's superior single heat port design is just one feature that contributes to the excellent stability of our baths.

Stability and Accuracy

Stability and accuracy are two of the most important words in temperature calibration.

Stability defines an instrument's resistance to change. How well can it maintain its equilibrium?

Accuracy is the correctness of measure or sameness of measure. In calibration work, sameness comparisons for accuracy determination are made against the International Temperature Scale maintained by the National Institute of Standards and Technology.

For industrial and commercial temperature measurement, accuracy to two decimal places is affordable and adequate. Three decimal accuracy is sometimes needed for scientific research or high precision calibration; however, anything past three decimal places is often technologically impractical and cost prohibitive. Even though it is not feasible to have temperature measuring instruments accurate to four or five figures beyond the decimal, it is desirable and possible to have instruments that maintain stability to four decimal places.

Resolution vs. Accuracy

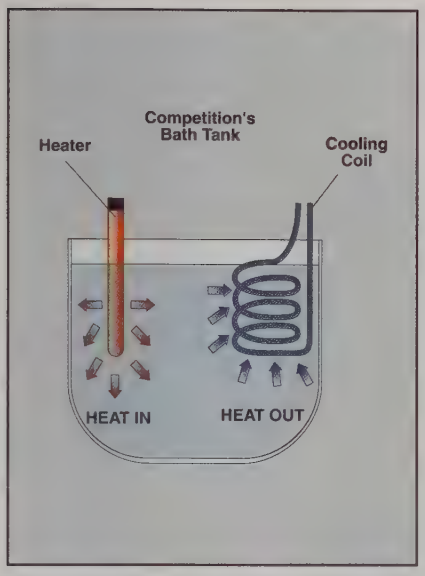
Controlling stability to a ten thousandth of a degree (one tenth of a millikelvin) requires measuring temperature change to a ten thousandth of a degree. However, measuring temperature change to four decimal places is not the same as having accuracy to four decimal places. This is one of the major points of confusion between the practical limits of absolute temperature measurement and controlling and measuring stability.

If temperature change is measured to four decimal places, the fourth decimal is the final digit that's resolute or firm. Therefore, the resolution of the instrument is 0.0001 and any change occurring in the fourth decimal is distinguishable by the instrument.

The resolution of any temperature measuring device is dependent upon its sensor having a short term drift less than the desired resolution, the sensor output per degree being large enough to measure the change required for that level of resolution and the readout of the instrument being capable of interpreting the required sensor output. For example, when all of these things are in place, a thermometer that is accurate to only one decimal place can still have 0.0001° resolution and detect temperature change to a ten thousandth of a degree.

Hart Technology

Engineers at Hart Scientific have produced proprietary electronic circuitry to achieve industry leading stability. Hart temperature controllers are designed to reject all noise that might interfere with the very small resistance changes that Hart electronics are capable of measuring. AC bridges reduce thermal EMFs. Custom, high precision, low coefficient resistors contribute to short and long term stability of



Other manufacturers place separate heaters and cooling coils directly into the bath tank. This not only creates obstructions but the inefficient heat ports reduce stability and increase gradient problems.

the temperature setting, and advanced filtering techniques force out line noise along with stray EMIs and RFIs.

In addition to outstanding analog control technology, in 1990 Hart engineers added a digital interface for ease of use and even better bath control. It's the latest in microprocessor-based digital electronics combined with the precision control of analog circuitry.

A proportional, integrating control function was designed to properly direct power to the bath heaters. Factory tuning eliminates most overshoot and allows the instrument to achieve maximum stability within 10 to 15 minutes of reaching its set temperature value.

If you'll be seeking accreditation for your calibration lab, NVLAP and other organizations around the world publish criteria stipulating the evaluation of your baths for stability and uniformity. See page 94 for more information you'll need to consider to make sure you get an adequate bath.

The technology employed in Hart baths is also successfully being used in other Hart instruments designed to measure temperature changes during the production of semi-conductors. Etching silicon in line widths less than five angstroms requires extreme temperature stability and sensing capabilities. Sensing and measuring temperature change to 0.00001, or five decimal places, has been a routine part of basic research for several years. Hart has brought this advanced technology into practical applications for the calibration industry.

For better comparison calibrations and multiple probe calibrations, Hart removes undesirable temperature gradients by avoiding the typical industry practice of using a separate heater and cooler immersed in the bath. Hart attaches its heaters to the outside of the stainless steel bath tank. If cooling is built-in, the refrigeration coils are sandwiched with the heater to the outside surface of the tank. The direct linking of heating and cooling to the tank surface creates a single large uniform "heat port." This construction requires additional handwork and craftsmanship but gives each bath unbeatable performance specs and long lasting quality.

Unbeatable Quality

Unlike lesser quality refrigeration baths, Hart baths have accessible valving for fine tuning cooling cycles. For any temperature below ambient, the refrigeration is balanced against the heater to refine and control stability. Other manufacturers simply set refrigeration full on or full off, creating too much raw power to counter with the heater and controller.

Hart baths save time and calibration problems by reducing drift, holding temperatures constant over longer periods of time, having lower and fewer temperature gradients and reducing error checking.

When your job depends on it, you can depend on us. Buy the best—buy Hart.

See how you can help the environment on page 147.

Enter Hart's new bear pun contest. If we use your pun in the newsletter we'll send you $5. Here's three puns to start your thinking:

Is this a bare thermistor probe?

This SPRT's going to be a bear to calibrate.

I'll bet this one barely works.

Finally, there's a convenient source for small quantities of bath fluids for any temperature range. Why pay for more than you need?

Hart Scientific carries a full line of bath fluids covering temperature ranges from –100°C to 550°C.

Viscosity, volatility and other properties that change with temperature affect the performance of fluids in controlled baths and circulators. Hart has tested and used each of the fluids we sell. Over the ranges recommended in the following table, each fluid remains at a low enough viscosity to be adequately pumped or stirred. Whether your application is industrial or critical lab calibration work, Hart fluids give you top performance and stability.

For temperature ranges too high for oils, we have a bath salt with a viscosity in the molten state similar to the viscosity of water. For your convenience, it is shipped in a granular form, making it easy to fill your bath.

Between its melting point of 150°C and 550°C, this salt has the highest temperature stability and uniformity available in a bath fluid. It does not smoke like oils or give off dust like "sand" or fluidized alumina baths. Check with your bath manufacturer before using this salt to make sure your equipment is compatible. Hart offers three standard bath models and custom designed units for use with this salt.

Fluid Specifications

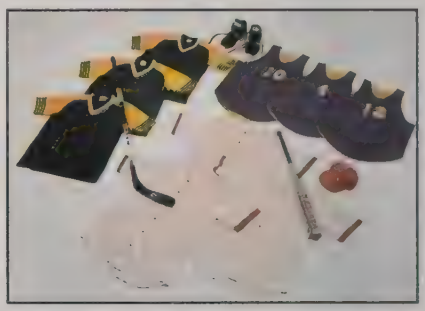
It's important to understand a few specifications before selecting a bath fluid. We've seen bath fluids advertised with a temperature range that spans from the freezing point to the flash point or beyond.

For example, type 710 silicone oil has a freezing point of –22°C, but freezing point has nothing to do with the point at which the oil becomes so thick it cannot be properly stirred. Type 710 oil should really only be used down to about 80°C. It's a viscosity issue not a freezing point issue. Usable range is the question. Suitability for calibration work is the specification that counts.

The usable viscosity range is determined by your bath's stirring or pumping design. Hart baths can be operated using fluids with up to 50 centistokes viscosity. This gives you additional usable range in the lower temperature levels of the fluid.

Some baths advertised as calibration baths require fluids with 10 centistokes or less viscosity to operate properly. The usable ranges in our tables on the next page assume the use of a Hart bath.

For more information on bath fluids see the article "Making the Right Choice in a Calibration Bath" on page 94.



We've been reading books on self-directed work teams. We're ready to try it but we wonder if our uniform colors are okay?

Ordering Information:

Fluid	Usable Range	Flash Point†	Part #	Price 1 gal.	Price 5 gal.
Halocarbon 0.8 Cold Bath Fluid	–100°C to 70°C	None	5019	$540	$2,300
Ethylene Glycol (Mix 1:1 with water)	–30°C to 110°C		5020	75	290
Silicone Oil Type 200.05	–40°C to 125°C	133°C	5010	270	1150
Silicone Oil Type 200.10	–30°C to 160°C	163°C	5012	290	1,200
Silicone Oil Type 200.20	10°C to 230°C	232°C	5013	260	1,100
Silicone Oil Type 200.50	30°C to 275°C	280°C	5014	225	1,050
Silicone Oil Type 550	0°C to 230°C	232°C	5016	590	2,500
Silicone Oil Type 710	80°C to 300°C	302°C	5017	595	2,520
Mineral Oil	0°C to 120°C	177°C	5011		85
Bath Salt Potassium Nitrate 53% Sodium Nitrite 40% Sodium Nitrate 7%	150°C to 550°C		5001	125 lbs.	$290

† Flash point is the temperature at which a vapor (not the fluid) will ignite if exposed to an open flame. When the flame is removed, the vapor will stop burning.

MAKING THE RIGHT CHOICE IN A CALIBRATION BATH

Buying a calibration bath is a major investment. Every customer should understand the choices being made. Each bath has its own individual operating characteristics that go beyond simple accuracy or its temperature range. This article will help you ask the right questions and ensure that you make the appropriate choices for your calibration needs.

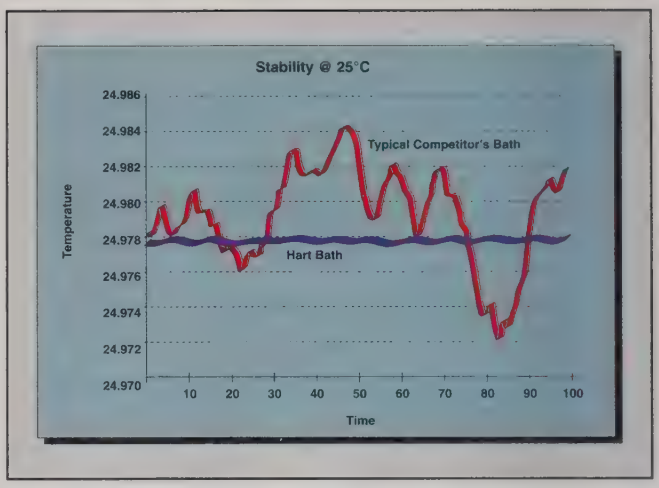
Temperature Range

Every bath has an advertised temperature range. This range is the bath's absolute temperature range, which may or may not have anything to do with its usable temperature range.

Two factors affect the actual usable temperature range of any bath. The first is choice of bath fluids. Bath fluids such as those discussed on page 92 have temperature ranges that differ from the temperature ranges of the baths. This is a limitation of the fluid and not the engineering of the mechanical equipment. It is possible to construct a bath that spans the temperature range of –80°C to 150°C. It is, however, impossible to find a matching fluid. Those fluids that perform best at –80°C will evaporate long before they get to 110°C, and low temp fluids are environmentally hazardous if used at higher temperatures.

The Hart Model 6045 bath has a "mechanical temperature range" of 20°C to 400°C. However, with Type 710 Silicone Oil the bath operates properly between 80°C to 300°C only. Below 80°C the fluid is too viscous for proper mixing for uniformity and stability. Above 300°C the flash point will be exceeded and a hazardous condition will exist.

To operate either the Hart 6045 or 6050 baths above 300°C, salt rather than oil is the preferred medium. Although the 6050 bath is listed as covering a range of 20°C to 500°C, the salt medium is only usable from 150°C to 500°C. The salt is a solid below 150°C.



Compare the stability of a Hart bath to other baths. Why settle for less performance?

The second factor affecting a bath's temperature range is the limits of mechanical design. In the case of a refrigerated bath, upper temperature ranges are limited to 150°C at the highest. This is the temperature limit of refrigeration gases. They will break down at higher temperatures and the life of the refrigeration system is reduced. Bath components are selected to match the intended temperature range of the bath. This maximizes performance while keeping costs in line with intended use.

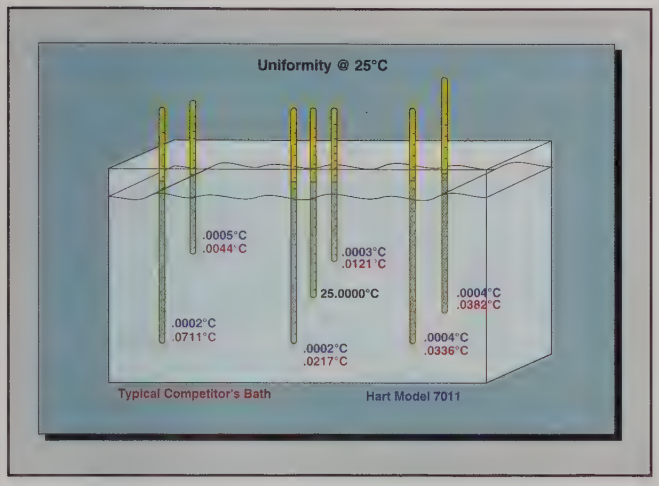
Fluids are not easy to change in a bath. If calibrations are required across a continuum of –80°C to 500°C, the best solution is three baths with three different fluids: a Hart Model 7080 bath with Halocarbon fluid to operate from –80°C to about 50°C; a Hart Model 6020 bath with Silicone Oil Type 200.20 for calibrations from 50°C to 205°C; and a Hart Model 6050 bath with salt for calibrations from 150°C to 500°C.

Some manufacturers may advertise a single well bath with a range of –80°C to 300°C. This may in fact be the bath's "mechanical temperature range" but it's not the range over which the bath is usable in any practical sense. With modifications, such as the removal of the refrigeration coil, the bath could operate above 150°C, but what is the utility of a bath that has to be altered in such a significant way to reach a specified temperature?

Even without the refrigeration issue there's still a fluids problem. The user would have to change fluids to move through the whole temperature range. Again, this is impractical and very expensive.

Some advertisements even misstate the temperature range of the fluids. Type 710 Silicone Oil has a freezing point of –22°C, but freezing point has nothing to do with the point at which the oil becomes so thick it cannot be properly stirred. It's a viscosity issue, not a freezing point issue. Usable range is the question. Suitability for calibration work is the specification that counts.

Viscosity is an issue that most manufacturers don't address in their advertising. For example, Hart's "Usable Range" fluid specifications are the ranges recommended for Hart baths only. Hart baths are designed to operate properly using fluids with up to 50 centistokes viscosity. Some baths advertised as calibration baths require fluids with 10 centistokes viscosity to



Gradients add error to your calibrations. We tested our bath and one of their's. This chart shows our gradients in blue and thier's in red. Which bath would youchoose?

produce the stated specs. Any other viscosity results in poor performance.

Ask about fluid viscosity requirements. Ask about actual bath performance at the temperature you intend to use the bath. Don't wait until you've got a bath in your lab to find out what its true performance is under your operating conditions.

Calibration Accuracy

The accuracy of a calibration depends on many things. As you calculate the accuracy or the uncertainty of your calibrations in a temperature bath, you should include the following factors in your estimations:

- The accuracy of your standards probe.
- The accuracy of the readout for that standard.
- The accuracy of the device reading the subject sensor's output.
- The stability of the temperature bath during the measurements.
- The uniformity of the bath in relation to temperature differentials between the standard and the sensor(s) under calibration.
- Operator technique.

Over the years we've seen plenty of advertisements for bath accuracy and stability that we know can't be done with the bath design being used. To achieve the specifications stated, the manufacturer would have to have violated several laws of physics and materials science. In testing these products, we've found that they may be very stable or accurate when set to room temperature, but that stability and accuracy quickly degrade at any temperature above or below room temperature, rendering the bath unacceptable for calibration work.

Find out what conditions are necessary for a bath to meet its advertised specifications. Does it require an equilibration block? Is the performance limited to a very narrow portion of its whole temperature range? Is the bath plagued by gradient problems? What's the performance in the temperature range you're most interested in?

Don't be fooled by claims that an equilibration block is the answer to bath stability problems. Because the block is a solid drilled to handle one size of probe, you lose the flexibility of calibrating probes of varying sizes and shapes. Blocks are inconvenient and require time-consuming placement and adjustment. Unless you have an extremely demanding spec that can't be reached without the assistance of an equilibration block, don't substitute one for bath performance.

Uniformity

Question uniformity issues the same way you question stability. Uniformity is critical to calibration work, especially if you have several probes that must be calibrated simultaneously.

Uniformity depends on the mixing of the bath fluid. Does the bath use a circulator pump for mixing? If it does, are there thermal flow patterns in the bath that will prevent good uniformity? Ask about both vertical and horizontal gradients.

In a laminar flow bath (one where the fluid is stirred in a circular pattern), there may be no horizontal gradients, but because the fluid is not mixed vertically, there are gradients between different depths in the bath. This is a problem if you use a long SPRT as your standard and the probes you calibrate are shorter. For example, if your probes are only 3 inches long, you can't immerse the SPRT to a depth of only 3 inches because you'll have a huge stem effect that will seriously affect its reading. So you need a bath that has good uniformity vertically as well as horizontally.

When you pay for excellence, you should get excellence. A good calibration bath will last ten to twenty years if you take care of it. It is a major investment. If you save a few dollars now but spend ten years or more fighting the bath to give you the performance you thought you would get, what did you really save?

Performance, ease of use, fluid requirements, quality and durability are all important factors in equipment purchase decisions. A bargain isn't a bargain if you have to keep paying for it over and over with your time.

INTRODUCTION TO DRY-WELLS

If you need a dry-well for temperature calibration, Hart has a complete line of calibrators to choose from. Select an industrial calibrator for portability, a high performance dry-well for accuracy and functionality, or a furnace for high temperatures and high performance.

All Hart dry-wells are backed up by our own in-house primary standards calibration lab, and Hart manufactures primary and secondary standards in the same plant as the dry-wells. With a Hart dry-well you don't pay extra for the NIST traceable certificate of calibration or the test data.

To help pick out the best model for your application, Hart has salespeople that are technically trained in temperature calibration. For maximum temperature accuracy with a dry-well, Hart also makes reference thermometers for comparison against your test instruments.

Dry-Well Calibrators

	Model	Range	Accuracy	Description	Price	Page
	9100 Handheld Dry-Well	33°C to 300°C 92°F to 572°F	±0.5°C to 100°C ±1°C to 300°C	World's smallest dry-well. Fixed block with 4" well depth. Two hole patterns available.	$995	100
	9120 Dry-Well	35°C to 199.9°C 95°F to 400°F	±0.5°C	Medium range dry-well. Interchangable inserts, 6" well depth. 0.1°C display and setpoint resolution.	1,945	102
	9121 Hi-Temp Dry-Well	50°C to 600°C 122°F to 1112°F	±0.1% ±1°C	Calibrates industrial RTD and thermocouples. Interchangeable inserts, 6" well depth. 1°C display and setpoint resolution.	2,995	103
	9125 Surface Dry-Well	35°C to 199.9°C 95°F to 400°F	±0.5°C	Calibrates surface sensors. Central plate uniformity is ±0.2°C.	2,250	114
	9130 Infrared Calibrator	35°C to 199.9°C 95°F to 400°F	±0.5°C	Checks non-contact IR sensors. Concentric grooved rings reduce surface reflectance.	$2,295	115

High Performance Dry-Well Calibrators

	Model	Range	Accuracy	Description	Price	Page
	9101 Zero Point Dry-Well	0°C 32°F	±0.02°C	All solid-state model. Easy to transport and operate. Replaces messy ice baths. 3 holes, 6" deep well.	$1,850	99
	9105 Low-Temp Dry-Well	–25°C to 140°C –13°F to 284°F	±0.1°C	No external cooling needed. Best accuracy in its class. Resolution: 0.01°C, Stability: ±0.02°C. RS-232 included, IEEE optional. Thermal switch test. Ramp and soak programming. Heats or cools in less than 10 minutes. Interchangeable inserts plus 4 fixed holes, 6" deep well.	4,995	110
	9123 High-Speed Dry-Well	35°C to 600°C 95°F to 1112°F	±0.1°C to 300°C ±0.5°C to 600°C	Heats to 100°C in 5 minutes, 600°C in 15 minutes. Resolution: 0.01°C, Stability: ±0.02°C. RS-232 included, IEEE optional. Thermal switch test. Ramp and soak programming. Interchangeable inserts, 6" deep well.	4,695	108
	9122 High-Capacity Dry-Well	35°C to 600°C 95°F to 1112°F	±0.12°C to 300°C ±0.5°C to 600°C	Calibrate 9 probes at once. 5 fixed holes plus 4 inserts. Resolution: 0.01°C, Stability: ±0.02°C. RS-232 included, IEEE optional. Thermal switch test. Ramp and soak programming. Interchangeable inserts, 6" deep well.	$5,495	106

Furnaces

	Model	Range	Stability	Features	Price	Page
	9113 Portable Furnace	200°C to 1100°C 392°F to 2012°F	±0.75°C	Use with type S TC for comparison calibrations. Small size for a furnace. RS-232 optional. Custom inserts available.	$5,295	116
	9112 Calibration Furnace	100°C to 1100°C 212°F to 2012°F	±0.1°C	Standard block fits 5 probes. Custom blocks available. Accommodates longer probes. RS-232 interface included. Gradients less than ±0.25°C at 1000°C.	$11,795	118

HALF THE WORK—TWICE THE RESULTS

Are you calibrating thermometers for process measurement and control? There's a possibility you're only doing half the job.

Many instrument shops calibrate industrial instruments with a simulator. Simulators produce an electronic signal that duplicates the correct signal made by a theoretically accurate thermocouple or RTD. This method is shown in Figure 1.

Once the simulator is connected to your readout or control instrument, you enter the desired output temperatures. You calibrate your instrument against the values entered in the simulator. This process calibrates the instrument to accurately read a sensor that conforms to the industry standard voltage, or resistance versus temperature curves. The calibration, of course, is only good if your sensor matches these industry specs, and as Figure 1 illustrates the sensor is not part of a simulator based calibration. Since up to 80% of industrial measurement error is normally in the sensor, you've got a problem if ISO or other quality standards require you to calibrate for system error.

In order to verify sensor compliance with industry standard curves, you'll have to have another device, in addition to the simulator, that generates an accurate temperature for the sensor to read and you to calibrate against. Of course, this temperature must be read by a device that does not contribute significant error to the sensor reading. Figure 2 shows this configuration, and the need for two additional instruments in the calibration process.

To avoid using a separate readout you can buy a simulator that reads temperature accurately as well as generates signals. This is a good alternative if you want to use sensors interchangeably with your instruments and, therefore, really don't have a "true system" against which to calibrate.

Using sensors interchangeably has a weakness in that sensors can't be adjusted to meet theoretical standard curves, thus you have to live with the sensor error or reject the sensor. Figure 2 also illustrates this point with the dry-well set to 0.00°C and the sensor reading 0.8°C, a high reading. Although the meter is adjusted for no error at 0°C using the simulator, when the sensor is connected to the instrument the combination of the two produces an overall error of 0.8°C. The system error of this combination is 0.8°C.

If you are not using sensors interchangeably then you should be calibrating for system error. System calibration is often less complicated and more reliable than calibration of each component of a system. Figure 3 shows a typical system calibration with the sensor in the dry-well attached to the readout instrument. The instrument is then adjusted for the error found in the combination of components. System calibration assures the highest possible accuracy for industrial thermometers.

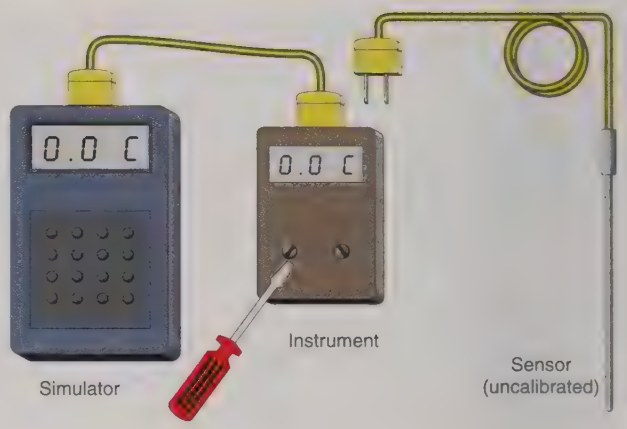


Figure 1

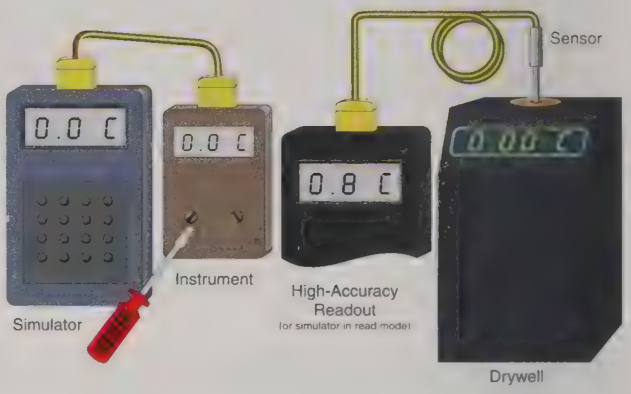


Figure 3

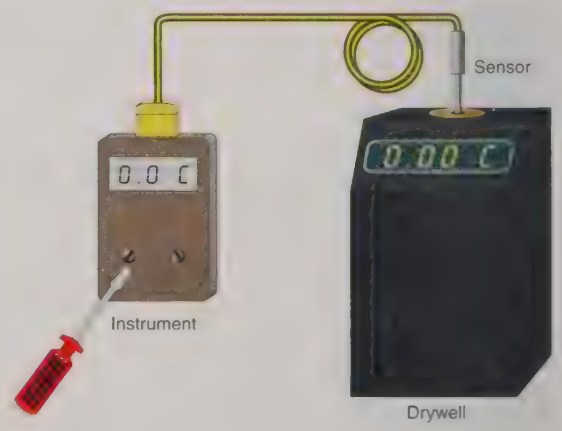


Figure 2

Zero Point Dry-Well	Model 9101
Solid state cooling technology	
Three test wells	
Recalibrate in your lab in minutes	
High accuracy in a Zero Point	

Does your calibration lab service include thermometer or sensor calibrations at 0°C? You can save money, labor and time with the Hart Model 9101 Zero Point Dry-Well.

The Hart Zero Point has three test wells for high volume throughput. All three wells are stable to ±0.01°C. One well has inserts for accommodating various probe diameters.

Unlike competitors' instruments, the Hart 9101 doesn't use a mechanically controlled sealed water cell. The 9101 takes advantage of the latest solid-state cooling technology, eliminating the possibility of the sealed water cell freezing while transporting the ice point to other locations. And our solid-state cooler is regulated by a precision electronic controller that can be recalibrated in your lab for convenient recertification. Simply place a certified standards thermometer in one of the wells and, if needed, tweak the 9101 controller until the standards thermometer reaches equilibrium at 0°C.

The 9101 is completely self-contained and doesn't require any user settings. Run it twenty-four hours a day for instant access to an accurate, traceable zero point. Set it up with the reference junction of a thermocouple for high accuracy thermocouple measurements.

Less costly than refrigerated baths, more accurate and less problematic than ice baths and more durable than competititors' units using sealed water cells, the Hart Model 9101 Zero Point Dry-Well is a good choice for any calibration lab.

Specifications Model 9101

Range: 0°C, 32°F

Stability: ±0.01°C

Total Instrument Error: ±0.02°C, typical; ±0.05°C max (18–25°C ambient)

Stabilization Time: Approx. 30 minutes, the ready lamp indicates stable control at 0°C

Size: 12.25" H x 8.5" W x 5.75" D (311 mm x 216 mm x 146 mm)

Power: 115 VAC 50/60 Hz (220 VAC optional, add "-E" to the model number.)

Well Dimensions: 2 wells, 0.25" dia x 6" D (6.35 mm x 152 mm), 1 well 0.28" dia x 6" D (7 mm x 152 mm) and includes one set of telescoping inserts to provide various smaller diameters

Carrying Case: Optional, ABS tough foam case with O-ring, watertight closing. Foam interior protects dry-well and accessories.

Calibration Certificate: Included, with data. States compliance and traceability to NIST standards.

Ordering Information:

9101 Zero Point Dry-Well	**$1,850**
2130 Well-Sizing Tube Set	**40**
9302 Rugged Carrying Case	**230**

See our complete line of carrying cases on page 144.

HANDHELD DRY-WELL

Handheld Dry-Well	Model 9100
Temperatures to 572°F (300°C)	
The only handheld dry-well available	
Includes 6-point NIST traceable certificate	
Fast and easy thermometer checks	

Hart builds some of the most accurate temperature measuring devices in the world. You may have already read about the Model 1575 Super-Thermometer. Hart engineering pushes the boundaries of measurement technology to bring you the best possible instruments, and now Hart is pushing the limits of size and weight to give you the portability you need along with measurement performance.

The Hart Model 9100 HDRC is a handheld dry-well calibrator with a range to 300°C (572°F). It's the first and only handheld dry-well made in the industry.

Check the accuracy of your thermometers and sensors without dragging a cart full of heavy, expensive equipment around your plant. It's simple, convenient and small. Anyone can learn to use it in less than 10 minutes.

Plug it in, switch it on, set the verification temperature with the front panel buttons and insert your probe into the proper sized well. Compare the temperature reading of your device to the display temperature, and the difference is the error in your device. The 9100 HDRC has a display resolution of 0.1 degrees.

If you need to change temperatures, the small, fan cooled aluminum block heats and cools very rapidly so it won't keep you waiting.

Check these numbers: accuracy: ±0.5°C between 33 and 100°C and ±1°C between 100 and 300°C; stability: ±0.2°C; stabilization time: 3 minutes; and the best number of all: the HDRC is priced below $1,000.

These units are perfect for the field. They're inexpensive so you can buy several for distribution throughout the plant. They'll pay for themselves in months by finding sensors that need immediate calibration and eliminating calibration of the ones that are working fine.

Need another reason to buy one? When you're checking digital meters with a simulator only, you're leaving the probe untested! Up to 80% of your error may be in the probe. The 9100 checks the combination of the probe and meter for *total system accuracy at real temperatures.*

You have a choice between two temperature block patterns. Choose the hole pattern that best fits your application. If your sensor is larger than $\frac{3}{8}$ inch, see our model 9120 or 9121 on

Eliminate production interruptions. Take the 9100 right to the plant floor to test sensors and thermometers.

The 9100 checks the combination of your probe and meter for total system accuracy at real temperatures.

pages 102 and 103 with changeable inserts up to 1 inch in diameter.

Each unit includes a NIST traceable certificate showing actual test data, which may be used in ISO 9000 quality programs. The instrument is only 2" high x 5" wide x 6" deep and weighs about 2 pounds. Hold the 9100 in your hand at 300°C and it isn't any warmer than a cup of coffee. The optional carrying case is almost unbreakable and has an O-ring seal to protect the HDRC from moisture. It holds the 9100 and its power cord.

Why a power cord, and not batteries? Well, field tests revealed that it took a battery as big as a car to heat an instrument to 300°C and keep it there while we did a calibration. Information gathered from our customer survey on battery powered instruments said that batteries as big as cars killed the portability feature and increased the price of the 9100 several thousand dollars above what most customers were willing to pay, so we overcame the problem with a power cord. And of course it's included at no additional cost.

Try one of these units, you'll love using it. Have you figured out what "HDRC" stands for? It's in the catalog. Look for it!

9100 in 9300 Carrying Case.

Specifications

Range: 92°F to 572°F, 33°C to 300°C

Accuracy:

Block A: 33 to 100°C: ±0.5°C
100 to 300°C: ±1°C

Block B: ±2°C

Stability: ±0.2°C

Heating Times: 33 to 300°C: 9.5 min.

Stabilization: 3 min

Cooling Times: 300 to 100°C: 14 min.

Holes:

Block A: Sized to fit these diameters: .062", .125", .156", 2 at .187", and .250" (1.5 mm, 3 mm, 4 mm, 4.8 mm, 6.35 mm)

Block B: .125", .187", .250:, and .375" (3 mm, 4.8 mm 6.35 mm, 9.5 mm)

Depth: 4", .062" hole is 3.5"

Power: 90 to 130 VAC, 50/60 Hz or 180 to 260 VAC, 50/60 Hz, 1.5 Amps max. (Add "-E" to model number for 240 V)

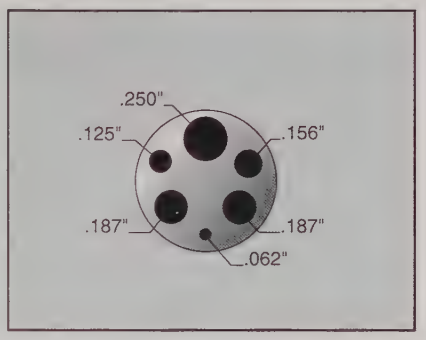
Size: 2.25 x 4.9 x 5.9 inches (57mm x 125mm x 150mm)

Weight: 2 lbs 3 oz. (1.08 Kg)

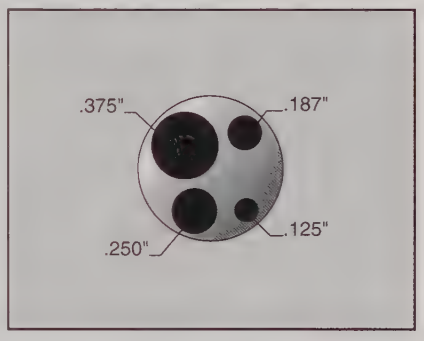
Certificate: Includes NIST traceable certificate of calibration with data at the following points: 50°C, 100°C, 150°C, 200°C, 250°C, and 300°C (122°F, 212°F, 302°F, 392°F, 482°F, and 572°F).

Ordering Information:

9100AC HDRC Block A °C	**$995**
9100BC HDRC Block B °C	**995**
9100AF HDRC Block A °F	**995**
9100BF HDRC Block B °F	**995**
9300 Rugged Carrying Case	**49**



9100 Block "A" shown at actual size.



9100 Block "B" shown at actual size.

DRY-WELL CALIBRATOR — Range: 35°C to 199.9°C

Dry-Well Calibrator	Model 9120
Microprocessor based PID digital controller	
Thermal cutout for temperature overshoot safety	
Standard and custom inserts for different sized probes	
Economical price	

For calibration of industrial probes below 200°C, Hart has its model 9120 Dry-Well.

The dry-well is controlled by a high-stability platinum RTD probe linked with a digital controller. The controller and probe are system calibrated to guarantee maximum accuracy. A NIST traceable standard provides the data for the 9120's calibration certificate. Each unit is carefully tested and individually adjusted to Hart specifications before shipment.

The 9120 incorporates the latest in dry-well temperature control and measurement technology. Typical block calibrators have temperature gradients as high as 18°C at less than four inches from the bottom of the test well. Our dry-wells produce gradients of less than 5°C within the four-inch span and less than 0.5°C within the normal 2-inch operating span. With the 9120's aluminum inserts (available in standard or custom sizes to accommodate almost any probe) you get the best thermal conductivity available.

The Hart Model 9120 weighs less than six pounds but comes packaged in a rugged aluminum enclosure that can handle any lab, field or industrial environment. It's light enough to take to the moon and tough enough to make it.

Check the price, check the specs and then check the competition. With Hart you can measure performance in the lab and not in the ad—the competition just doesn't measure up.

Specifications — Model 9120

Range:

°C Version: 35°C to 199.9°C

°F Version: 95°F to 400°F

Stability: ±0.1°C

Resolution: 0.1°C, 1°F

Accuracy: ±0.5°C traceable to NIST

Controller: Microprocessor-based PID digital controller.

Temperature Setting: pushbutton entry with rapid scrolling

Cooling: Built-in cooling fan

Stabilization Time: Approx. 10 min

Test Well: 1" diameter x 6"deep. Available inserts size the well for best thermal contact with the probe.

Inserts: Each dry-well is shipped with one 2106 insert (.25").

Power: 120 VAC (240 VAC optional, add "-E" to the model number.)

Size: 3.5" H x 7.5" W x 10" D (89 mm x 191 mm x 254 mm)

Weight: With 1 insert, 6 lbs (2.7 kg)

Calibration Certificate: Included, with data. States compliance and traceability to NIST standards.

Ordering Information:

9120C Dry-Well °C	**$1,945**
9120F Dry-Well °F	**1,945**
9301 Rugged Carrying Case	**155**
2114 Blank Insert	**110**
2103 1/8 Insert (3.2 mm)	**110**
2104 5/32 Insert (4 mm)	**110**
2105 3/16 Insert (4.8 mm)	**110**
2106 1/4 Insert (6.35 mm)	**110**
2107 5/16 Insert (7.9 mm)	**110**
2108 3/8 Insert (9.5 mm)	**110**
2109 1/2 Insert (12.7 mm)	**110**
2110 5/8 Insert (15.9 mm)	**110**
2111 3/4 Insert (19 mm)	**110**
2112 7/8 Insert (22 mm)	**110**
2120 1 User Specified Hole	**155**
2121 2 User Specified Holes	**205**

HI-TEMP DRY-WELL — Range: 50°C to 600°C

Hi-Temp Dry-Well	Model 9121
Applications to 600°C (1112°F)	
Portable and rugged for field use	
Certificate of traceability to NIST	

Hart's Model 9121 Hi-Temp Dry-Well Calibrator is the best choice for easy, low cost, accurate calibrations of industrial type probes up to 600°C. Its light weight and rugged portability make it ideal for on-site work in your plant or in your mobile calibration lab. Other calibrators in this class cost considerably more and don't perform as well.

The 9121 achieves accuracy of ±0.1% ±1°C over its entire temperature range and has a NIST traceable certificate of calibration included with each instrument. The advanced digital controller is easy to set with fast pushbutton data entry. Two separate L.E.D. displays show your set temperature and the actual control temperature simultaneously.

All Hart dry-wells are calibrated so the dry-well's sensor reads the true temperature in the block. When you put your sensor in the well, you are comparing it against the dry-well's calibrated sensor.

Special heater placement and application of insulation combine to minimize gradients along the depth of Hart's calibration well. The 9121's temperature uniformity is better than any other calibrator in its price range.

The field-tough instrument enclosure protects your calibrator in any environment. The 9121 can be used in the horizontal benchtop position in the lab or in the vertical position in tight spaces and on the plant floor.

The optional sealed carrying case further protects the calibrator in transit and keeps all accessories handy. Our dry-well case is the toughest, most durable case we've ever found.

No other calibrator offers these capabilities for a similar price. The Hart 9121 is the best value for general purpose calibrations over this industrial temperature range.

Specifications — Model 9121

Range:

°C Version: 50°C to 600°C

°F Version: 122°F to 1112°F

Stability: Better than ±1°C (±0.3°C typical)

Resolution: 1°C or °F

Accuracy: ±0.1% ±1°C

Cooling: Built-in cooling fan

Stabilization Time: Approx. 15 min

Test Well: 1" (25 mm) dia x 6" (152 mm) deep

Insert: Each dry-well is shipped with one 2136 insert (.25")

Power: 120 VAC (240 VAC optional, add "-E" to the model number.)

Size: 5.8" H x 8.7" W x 15" D (147 mm x 221 mm x 381 mm)

Weight: With one insert, 12 lbs (5.5 kg)

Calibration Certificate: Included, with data. States compliance and traceability to NIST standards.

Ordering Information:

9121C	Hi-Temp Dry-Well °C	**$2,995**
9121F	Hi-Temp Dry-Well °F	**2,995**
9302	Rugged Carrying Case	**230**
2131	Blank Insert	**125**
2132	1/16 Insert (1.6 mm)	**125**
2133	1/8 Insert (3.2 mm)	**125**
2134	5/32 Insert (2 mm)	**125**
2135	3/16 Insert (4.8 mm)	**125**
2136	1/4 Insert (6.35 mm)	**125**
2137	5/16 Insert (7.9 mm)	**125**
2138	3/8 Insert (9.5 mm)	**125**
2139	1/2 Insert (12.7 mm)	**125**
2140	5/8 Insert (15.9 mm)	**125**
2141	3/4 Insert (19 mm)	**125**
2142	7/8 Insert (22 mm)	**125**
2150	1 User Specified Hole	**165**
2151	2 User Specified Holes	**225**

DRY-WELL ACCURACY

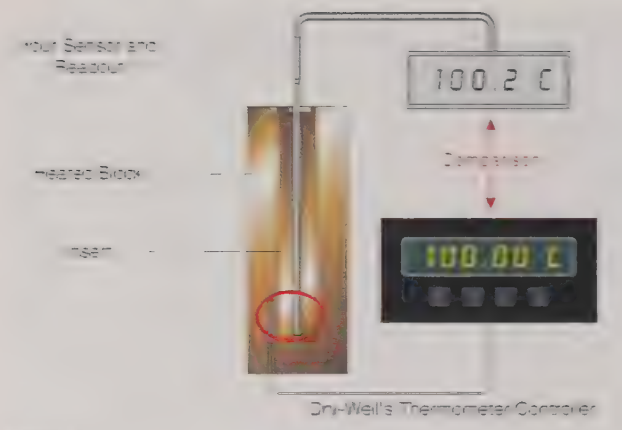


Figure 1
Dry-Well with Reference Standard

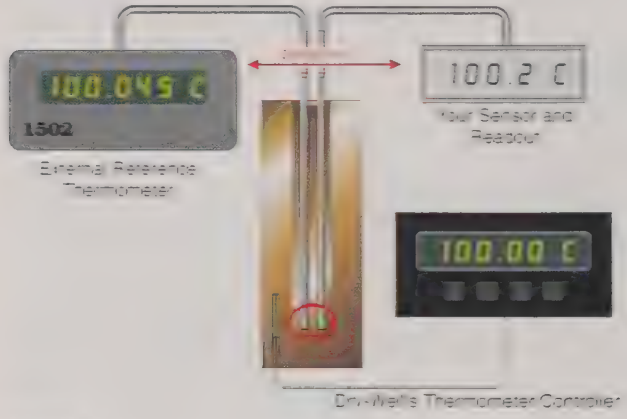


Figure 2
External Reference Thermometer

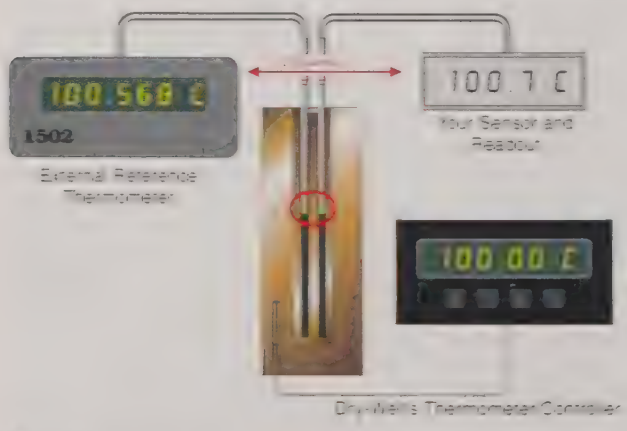


Figure 3
Insert with Reference Thermometer

Dry-wells are popular industrial calibration devices. Most users simply compare the reading from their industrial thermometer to the reading on the dry-well controller's display. Thus the controller display serves as a reference thermometer in the calibration process (see Figure 1). If the controller is calibrated against a traceable standard, then the controller display is more than a reference thermometer, it is a traceable reference.

At Hart Scientific we calibrate our dry-wells against NIST traceable standards thermometers and publish in the catalog the accuracy of the dry-well's own thermometer display. This is the guaranteed accuracy of the instrument. Each dry-well comes with a certificate of calibration included in the base price. All Hart dry-wells can easily be checked for accuracy and recalibrated when necessary.

Some dry-well manufacturers don't publish the accuracy of their dry-well's controller. They prefer to state the "best accuracy" of the instrument which is the accuracy of the dry-well under ideal conditions with an external reference matching the "best accuracy" specification. Now that's just not cricket!

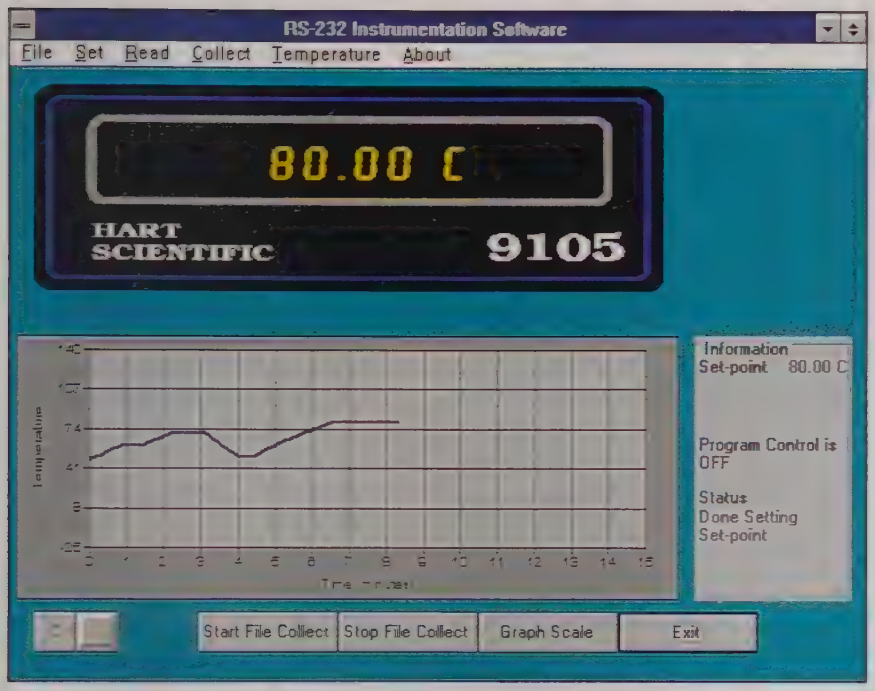
Now we're not arguing that dry-well accuracy can't be improved with the use of an external reference, because it can (as shown in Figure 2). In fact, we manufacture a variety of high accuracy electronic thermometers such as the Model 1502 "Tweener" which improves comparison calibration accuracy significantly. We just don't state the accuracy of our dry-wells as a combination of the dry-well and an external reference.

Other dry-well companies offer, for an additional charge, a certificate of calibration for their dry-wells. This brings up the question of whether they calibrate their dry-wells before they ship them if you don't pay for their certificate. If they do calibrate them against traceable standards, is their extra charge of several hundred dollars for the certificate simply their cost for printing out the certificate? The logic of all this eludes us. If you're buying a dry-well with the accuracy of the internal thermometer specified, then it has to be calibrated before shipment, period. It's that simple, so we supply the certificate along with the dry-well as part of the Hart package at no extra charge.

In addition to calibrating our dry-wells against NIST traceable standards, we also have several well options available to accommodate specific calibration problems. If you want to use an external reference (Figures 2 and 3), order a 2-hole insert. When you calibrate short probes, insert the reference thermometer to the same depth as your probe.

All of the temperature calibration products we manufacture are designed to work together to give you almost any combination of accuracy, price, and portability you need.

DRY-WELL SOFTWARE



Dry-Well Software	Model 9930
Complete PC control of models 9123, 9105, and 9122 dry-wells	
No programming; simple point and click commands	
Free with above dry-wells	

If you're using a Hart Model 9123, 9105 or 9122 dry-well with your computer, why not automate the process with Hart's new dry-well control software package for Windows™?

It's easy to learn and simple to use. All control functions and parameters are entered using convenient dialog boxes. You won't have to spend time reading a three-inch-thick software manual to learn to control all Hart dry-well functions and automatically collect your data.

This graphical package features an on-screen dry-well front panel for programming all dry-well functions, along with a variety of data collection options, including a real time display of temperature data using a scaleable strip chart recorder simulator, calibration parameter storage, stored variable communication protocols for using the software with different computers and built-in ramp and soak functions.

It's for Windows™ so you need Windows™ 3.1, MS-DOS® 3.0 or higher, a VGA color monitor, a fast computer with one RS-232 port, at least 5 Megs of available hard disk space and a dry-well with firmware 3.1 or higher. If you don't know what version of the firmware your dry-well is using, call us and we'll tell you. If it's an earlier version, we can update it for a nominal charge.

Like all Hart products, this one is easy to use, reliable and does exactly what we say it does. We use it to control our instruments—you should too!

Features:

- Set temperature setpoint.
- Set ramp and soak test parameters from a window and save the settings to a file for repeated use.
- View the temperature displayed on a strip chart in real time.
- Change the strip chart scale to check stability or zoom out to see changing trends.
- Set the ramp to maximum speed or select your own speed.
- Collect data points from dry-well.
- Control and collect data from a thermal switch test.
- Set and store communication settings.
- Adjust the setpoint approach control to minimize overshoot.
- Change the dry-well's calibration parameters after self-calibration.

System Requirements:

- Microsoft Windows™ 3.1 or higher
- MS-DOS® 3.0 or higher
- PC capable of running Windows™ 3.1
- VGA color monitor
- 1 Floppy Drive: 1.2M or 1.44M
- 1 RS-232 Port
- Hard drive with 5 Mb free disk space
- Hart Dry-Well Model 9122, 9123, or 9105 w/firmware Ver 3.1 or higher

THIS FREE SOFTWARE COMES WITH THESE DRY-WELLS:

9105 9123 9122

Page 110 Page 108 Page 106

HIGH CAPACITY DRY-WELL CALIBRATOR

High Capacity Dry-Well Calibrator	Model 9122
Calibrate nine probes simultaneously	
Best available accuracy in a dry-well	
Includes NIST traceable certificate with data	

Too many probes to calibrate? Not enough time? With Hart's Model 9122 High Capacity Dry-Well you can calibrate nine probes simultaneously, manually or under automation. Load your probes in the 9122 and start your calibration. You won't have to touch them again until the calibration is complete.

The temperature in any of the nine test wells is accurate to ±0.2°C up to 200°C and ±0.7°C at 600°C. This includes all errors such as uniformity between wells, repeatability, and the uncertainty of the NIST traceable calibration performed in our factory. This is the worst case spec. Put your probe in any well and compare its output to the 9122's display with confidence.

If you're testing only one probe, test it in the center well where the accuracy is a bit better. You can count on ±0.1°C accuracy up to 200°C and ±0.5°C at 600°C.

When testing several probes at once, you can improve the accuracy of your calibrations by using an external reference thermometer. Use our Smart Probe or one of our bench thermometers in a comparison calibration method to achieve combined errors of 0.1°C or less. At 100°C, the excellent uniformity of the 9122 contributes only 0.05°C error to your calibration.

If you're looking for throughput, these low gradients and the flexible well design improve your efficiency. Five of the wells are drilled for 1/4 inch probes and the other four wells handle Hart's standard or custom drilled inserts for any probe diameter you need to calibrate.

Completely automate your probe certifications using Harts new 9931 Individual Sensor Calibration System shown on page 112. It checks up to 100 setpoint temperatures of your RTD or thermocouple and prints a certification report showing errors.

If you are looking for a competitor's unit to compare specs with the 9122, you won't find one. No other calibrator lets you calibrate as many probes simultaneously. You would need two or three of their units to do the work of the 9122.

The 9122 now comes with RS-232 interface and instrument control software for automation with a PC (see page 105). IEEE-488 is also available as an option.

For semi-automated calibrations, the 9122 can be programmed through its own front panel to automatically set and hold up to eight temperatures in sequence and duration times of your choice.

Hart's Model 9122 is the only calibrator available with so many test wells and this level of precision, convenience and automation possibilities. Why settle for less?

Specifications	Model 9122

Range: 35°C to 600°C (95°F to 1112°F)

Accuracy (center well):

±0.10°C at 100°C
±0.12°C at 300°C
±0.50°C at 600°C

Combined Errors for Tests in any Outer Well: ±0.15°C at 100°C
±0.25°C at 300°C
±0.70°C at 600°C

Resolution: 0.01°C or °F

Stability: ±0.02°C at 100°C
±0.03°C at 300°C
±0.05°C at 600°C

Uniformity Between Wells:
±0.05°C at 100°C
±0.12°C at 300°C
±0.45°C at 600°C

Display: LED, °C or °F, user selectable

Size: 13" H x 8" W x 12" D (330 mm x 203 mm x 305 mm)

Power: 110 VAC, 60 Hz (220 VAC 50 Hz optional, add "-E" to the model number.)

Cooling: Built-in fan

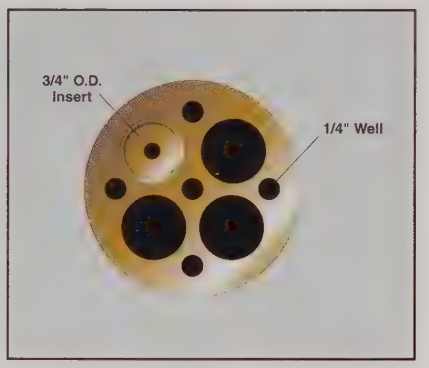
Test Wells: Five .25" x 6" (6.35 mm x 152 mm) wells, four .75" x 6" (19 mm x 152 mm) wells fit inserts listed

Interface: RS-232 standard, IEEE-488 (optional)

Calibration Certificate: Included, with data. States compliance and traceability to NIST standards.

Ordering Information:

9122 Dry-Well (Includes 1/8, 3/16, 3/8, and 1/2 inserts)	**$5,495**
2125 IEEE-488 Option	**395**
9304 Carrying Case	**350**
2152 Blank Insert, 3/4 inch (19 mm)	**125**
2154 1/8 Insert (3.2 mm)	**125**
2155 5/32 Insert (4 mm)	**125**
2156 3/16 Insert (4.8 mm)	**125**
2157 1/4 Insert (6.35 mm)	**125**
2158 5/16 Insert (7.9 mm)	**125**
2159 3/8 Insert (9.5 mm)	**125**
2160 1/2 Insert (12.7 mm)	**125**
2161 5/8 Insert (15.9 mm)	**125**



9122 isothermal block showing the nine available wells with an insert in one of the 3/4 inch wells.

See page 105 for free software to control this calibrator.

See page 112 for Hart's new calibration software to completely automate RTD and thermocouple certifications.

Oh boy, the Chairman and President are designing new products again. We buy them a new set of blocks every year. It's our way of saying Merry Christmas, and if they gave us a bigger Christmas bonus we'd get them a nicer gift.

HIGH-SPEED DRY-WELL CALIBRATOR

High-Speed Dry-Well Calibrator	Model 9123
Programmable ramp and soak feature	
Heats to 600°C in only 14 minutes	
Accuracy of ±0.1°C below 300°C—best in the industry	

Hart's Model 9123 calibrator is one of our most popular products. The 9123's "smart" controller automatically increases fan speed for cooling the block and decreases fan speed at your setpoint for maximum stability during calibrations. This gives you quick response without sacrificing measurement performance.

Look at the specs: accuracy is ±0.1°C up to 300°C and ±0.5°C to 600°C, resolution is 0.01°C, stability of ±0.02°C, heating and stabilization times are within 20–25 minutes, and the test well is 6 inches deep to minimize stem effect when calibrating long probes.

Control stability is typically ±0.02°C and is directly readable from the display so you don't have to guess. A custom-drilled insert is available with two probe holes for comparison calibrations using a reference of your choice. Uniformity between the two holes at the same depth is typically ±0.05°C (see drawing opposite page); your calibration accuracy is only limited by the accuracy of your standards thermometer.

A thermal switch test feature is standard on the 9123. Connect your switch, fuse or cutout to the special binding posts on the back panel of the calibrator and start your heating cycle. The display locks in the temperature that triggers the thermal switch.

New programming features for controlling heating rates have been added to make thermal switch testing easier and more efficient. For semi-automated sensor testing, up to eight ramp and soak steps are programmable for unattended test sequencing. RS-232 is included and an IEEE interface option can be ordered for computer controlled calibration systems.

Recalibrate the 9123 through the front panel of the controller. No time-consuming instrument disassembly or hard-to-reach trimpots. It only takes a few minutes to ensure your calibration accuracy.

For best accuracy and resolution of any dry-well in its class your best choice is the 9123, backed by Hart's primary standards calibration lab.

Specifications Model 9123

Range: 35°C to 600°C (95°F to 1112°F)

Accuracy: ±0.1°C to 300°C
±0.5°C to 600°C

Resolution: 0.01°C or °F

Stability: ±0.02°C to 300°C
±0.05°C to 600°C

Heating Rate:
Ambient to 100°C: 5 min
Ambient to 600°C: 14 min

Stabilization:
±0.1°C of setpoint: 6 min

Display: LED, °C or °F

Size: 13" H x 8" W x 12" D (330 mm x 203 mm x 305 mm)

Weight: 15 lbs (6.8 kg) including well insert

Power: 110 VAC, 60 Hz (220 VAC 50 Hz optional, add "-E" to the model number)

Test Wells: 1" x 6" (25.4 mm x 152.4 mm) well accepts inserts, .25" (6.35 mm) insert included

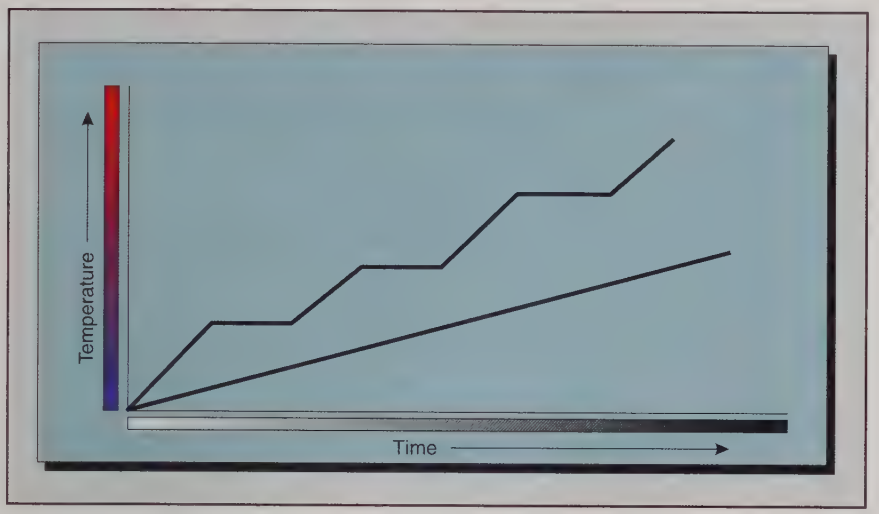
Calibration Certificate: Included, with data. States compliance and traceability to NIST standards.

Ordering Information:

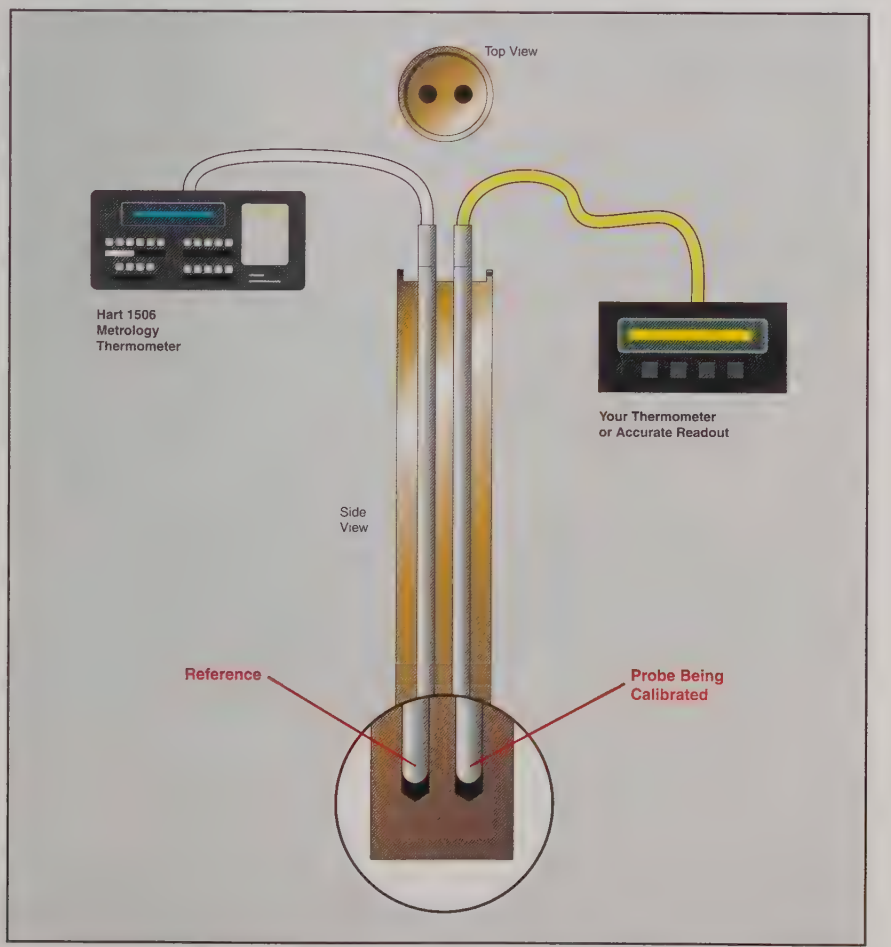
9123 Dry-Well	**$4,695**
2125 IEEE-488 Option	**395**
2131 Blank Insert	**125**
2132 1/16 Insert (1.6 mm)	**125**
2133 1/8 Insert (3.2 mm)	**125**
2134 5/32 Insert (4 mm)	**125**
2135 3/16 Insert (4.8 mm)	**125**
2136 1/4 Insert (6.35 mm)	**125**
2137 5/16 Insert (7.9 mm)	**125**
2138 3/8 Insert (9.5 mm)	**125**
2139 1/2 Insert (12.7 mm)	**125**
2140 5/8 Insert (15.9 mm)	**125**
2141 3/4 Insert (19 mm)	**125**
2142 7/8 Insert (22 mm)	**125**
2150 1 User Specified Hole	**165**
2151 2 User Specified Holes	**225**
9304 Carrying Case	**350**

See page 105 for free software to control this calibrator.

See page 112 for Hart's new calibration software to completely automate RTD and thermocouple certifications.

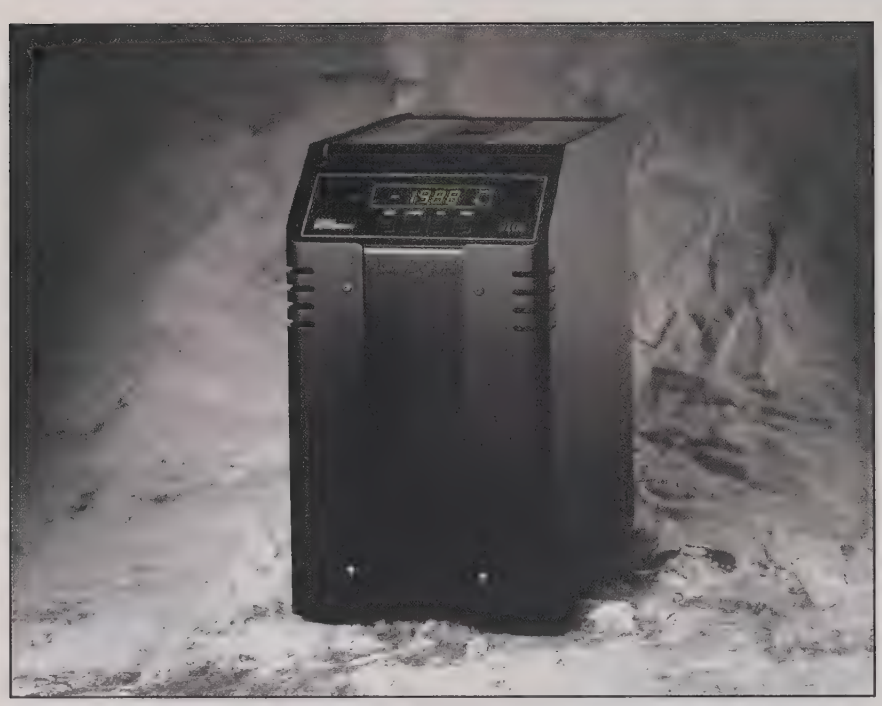


The programmable ramp and soak function lets you perform semi-automated sensor testing—or you can set a single controlled ramp to test thermal cutouts.



2151 2-Hole Insert for Comparison Calibrations with an External Standards Thermometer. See article on page 104.

LOW-TEMP DRY-WELL



Low-Temp Dry-Well	Model 9105
Best accuracy in its class	
Fastest heating and cooling rates in the industry	
Reaches higher temperatures than other cooled dry-wells	

Hart's Model 9105 Low-Temp Dry-Well covers the temperature range of 50°C below ambient to 115°C above ambient, for a typical temperature range of –25°C to 140°C.

The 9105 uses no external cooling fluids. All cooling and heating is done with solid-state thermoelectric devices for control stability of ±0.02°C and accuracy of ±0.1°C. The high precision microprocessor-based controller has 0.01 degrees resolution.

If you use a standards probe, the 9105 has the test well uniformity and the stability to give you ±0.05°C calibration accuracy. This is an absolutely unbeatable spec in an instrument of this type across this temperature range. And you can recalibrate it through pushbuttons on the front panel making it the easiest instrument in its class to recertify.

A thermal switch test feature is standard on the 9105. Connect your switch, fuse or cutout to the special binding posts on the back panel of the calibrator and start your heating or cooling cycle. The display locks in the temperature that triggered the thermal switch.

To automate your work, use your PC and the included RS-232 interface. Each 9105 also includes our 9930 Instrument Control Software package for Windows™ which allows you total control of the calibrator from your PC.

To automate a sensor calibration, turn to our 9931 Individual Sensor Calibration System, also for Windows™ which allows you to set up to 100 setpoints and automatically print a certification report of accuracy for your sensor.

With the 9105 you get the best accuracy and display resolution in the industry. The accuracy is verified with NIST traceable instruments from our fully equipped primary standards calibration lab. Your 9105 will include the certfication report with the test data — you won't have to pay extra for it.

And don't worry about changing the setpoint temperatures. The Model 9105 has the fastest heating and cooling rates in the industry. It takes only ten minutes to reach any setting. You get speed, accuracy and stability all in one unit.

Specifications Model 9105

Range: –25°C to 140°C (–13°F to 284°F)

Stability: ±0.02°C (±0.04°F)

Accuracy:

Drilled Wells:

with reference: ±0.05°C (0.09°F)

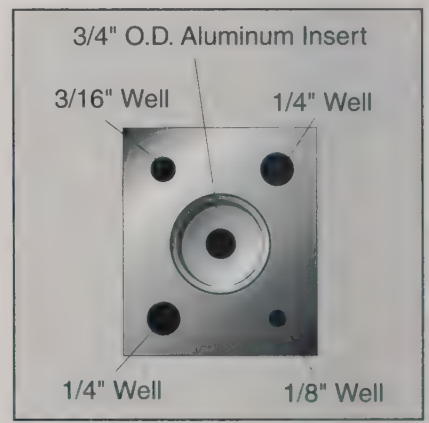
without: ±0.1°C (0.18°F)

Center Well:

–20°C ±0.23°C (.42°F)

0°C ±0.1°C (.18°F)

140°C ±0.45°C (.81°F)



Well size and location on the 9105. The center well takes standard or custom inserts.

Uniformity:

Drilled Wells: ±0.05°C (0.09°F)

Center Well:

–20°C ±0.23°C (.41°F)
0°C ±0.08°C (.14°F)
140°C ±0.45°C (.81°F)

Resolution: 0.01°C or °F

Display: LED, °C or °F, user selectable

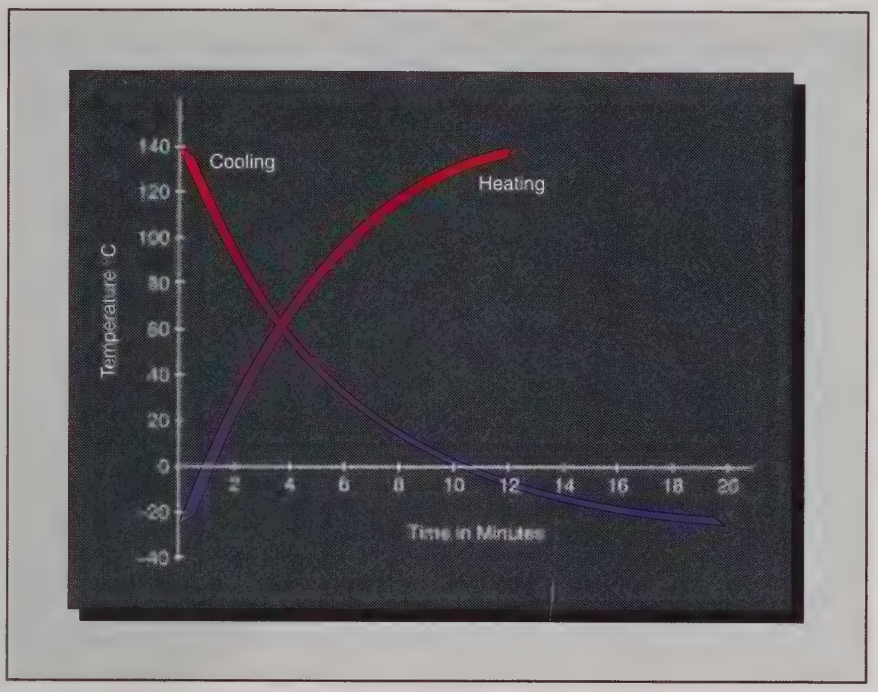
Test Wells: 4 predrilled wells: Two 1/4, one 3/16, and one 1/8 inch x 6 inches deep. Center well accepts a removable insert.

Size: 13" H x 8" W x 12" D (330 mm x 203 mm x 305 mm)

Power: 110 VAC, 50/60 Hz, 750 Watts (220 VAC optional, add "-E" to the model number)

Calibration Certificate: Included, with data. States compliance and traceability to NIST standards.

Weight: 30 lbs (13.6 kg)



9105 Heating and Cooling Rates.

Ordering Information:

9105 Low-Temp Dry-Well	**$4,995**
2125 IEEE Interface Option	**395**
2168 Blank Insert	**110**
2169 1/16 Insert (1.2 mm)	**110**
2170 1/8 Insert (3.2 mm)	**110**
2171 5/32 Insert (4 mm)	**110**
2172 3/16 Insert (4.8 mm)	**110**
2173 1/4 Insert (6.35 mm)	**110**
2174 5/16 Insert (7.9 mm)	**110**
2175 3/8 Insert (9.5 mm)	**110**
2176 1/2 Insert (12.7 mm)	**110**
2177 5/8 Insert (15.9 mm)	**110**
2150 1 User Specified Hole	**165**
2151 2 User Specified Holes	**225**
9304 Carrying Case	**350**

9304 Carrying case for 9105, 9123, and 9122 Dry-Wells.

See page 105 for free software to control this calibrator.

See page 112 for Hart's new calibration software to completely automate RTD and thermocouple certifications.

INDIVIDUAL SENSOR CALIBRATION SOFTWARE

Are you calibrating RTDs or thermocouples in the range of –25°C to 600°C?

If you've been looking for a way to increase your productivity without sacrificing the quality of your work, try Hart's new automation software package, the 9931 Individual Sensor Calibration Software. It does the repetitive work for you while giving you all the data needed to check the calibration process and provide traceability.

Everybody that sells software says their software is "user friendly" so we won't repeat that line. But we will say that while it's not Gumpware, it takes less time to learn than doing one thermocouple calibration, and it comes from a company that does RTD and thermocouple calibrations every day. It will pay for itself with every calibration you do.

The software is written to run under Windows™ and to take full advantage of the graphics and menuing capabilities of Windows™. The pull-down menus are logical and easy to understand. There's an on-screen electronic strip chart recorder and the screen continuously shows the current set temperature, elapsed time, current status, and any sensor error for each reading as the readings are taken.

Test data is stored in a database for archiving or report printing. Each calibration report shows the temperature error of the sensor at each selected set point. The report format contains the required information for NIST traceability and for ISO 9000 quality programs. The software will automatically print a NIST traceable certificate for you, if you need it.

The software includes a stand-alone black box interface for connecting the two dry-wells required to cover the temperature range of –25°C to 600°C to your computer. When it's time to switch the sensor from one dry-well to the other to complete the calibration, the computer prompts you. You can also use the software with a single dry-well for an automated calibration.

The Model 1531 black box interface reads 100Ω Platinum RTDs (3- or 4-wire; 385 or 392 Alpha) and all industrial standard thermocouple types (J, K, T, E, R, S, and B) without any hardware configuration changes.

Remember, the package comes complete with everything you need except the dry-wells and your sensors.

Don't you deserve a break today? With Hart's 9931 Individual Sensor Calibration System, you get it.

1531 Specifications

Thermocouple Types: J, K, T, E, R, S, and B

RTD Types: 100Ω Platinum, 385 or 392 Alpha, 3- or 4-wire

Typical Accuracy (includes CJC Error @ 25°C):

		°C	°F
RTD	385 Alpha	0.20	0.36
	392 Alpha	0.20	0.36
Thermocouple	J	0.35	0.63
	K	0.65	1.17
	T	0.45	0.81
	E	0.30	0.54
	R	1.10	1.98
	S	1.25	2.25
	B	1.45	2.61

Certification: 1531 Includes NIST traceable certificate

Dimensions: 2.25"H x 5.75"W x 6.0"D (5.72 cm x 14.61 cm x 15.24 cm)

Weight: 2 lbs (0.9 kg)

System Requirements:

- Hart Super Dry-Well Model 9105, 9122, or 9123.
- IBM PC Compatible with 80386 or better processor.
- 4MB free RAM.
- 5MB free hard disk space.
- Windows™ 3.1
- 1 computer serial port.
- 1 floppy drive

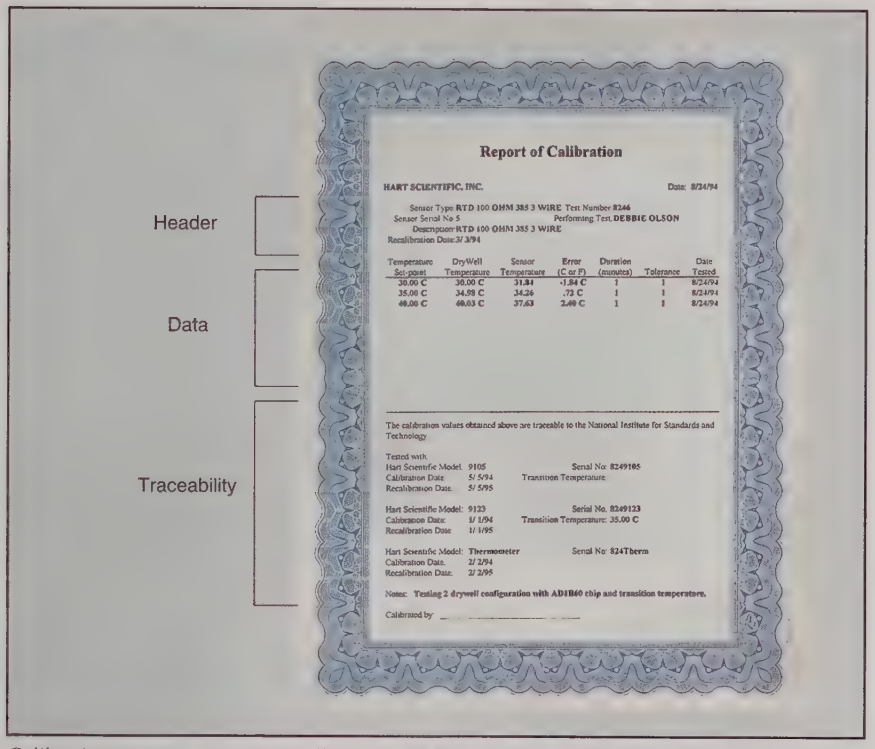
Certification Reports

The 9931 software stores test data and allows you to print a calibration report. You can customize the report by including additional information in the header and note fields. The report is divided into three key parts: the header, data, and traceability sections.

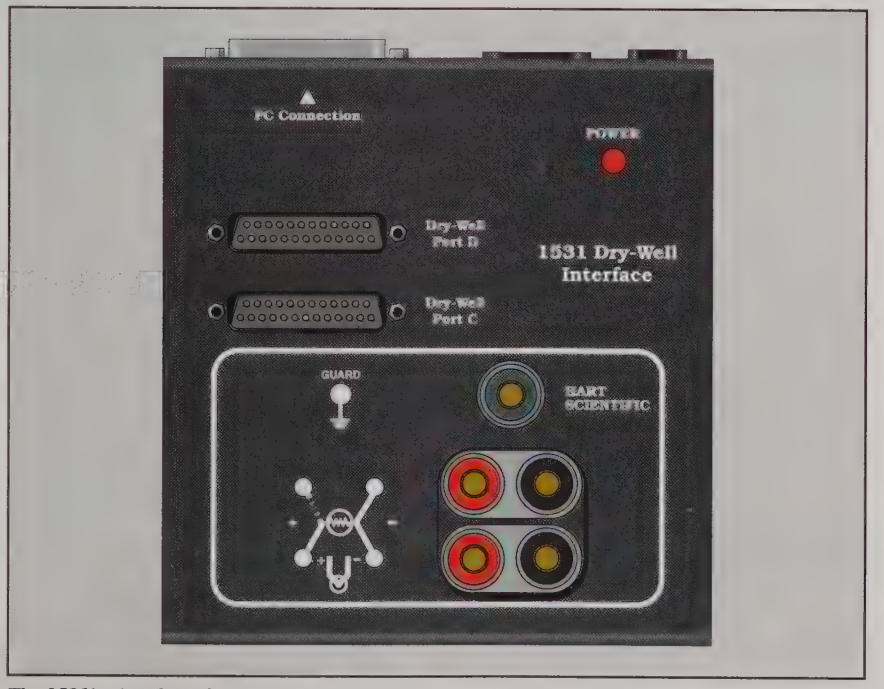
The header shows the sensor, description, user name, and recalibration date. Use the recalibration date, which is user changeable, to meet the requirements of your in-house quality program.

The data section shows the setpoints selected and the error that was found at each setpoint temperature as compared to the dry-well reference. Also shown are the duration and the stability tolerance selected at each temperature.

The traceability section displays the NIST traceable test numbers of the dry-well(s) and the 1531 thermometer. This information is stored to the data file and is entered at the software setup.


Header
Data
Traceability
Report of Calibration
HART SCIENTIFIC, INC.
Date: 8/24/94
Sensor Type: RTD 100 OHM 385 3 WIRE Test Number: 8246
Sensor Serial No: 5
Performing Tech: DEBBIE OLSON
Description: RTD 100 OHM 385 3 WIRE
Recalibration Date: 3/ 3/94
Temperature Set-point
DryWell Temperature
Sensor Temperature
Error (C or F)
Duration (minutes)
Tolerance
Date Tested
30.00 C 30.00 C 31.84 -1.84 C 1 1 8/24/94
35.00 C 34.98 C 34.26 .72 C 1 1 8/24/94
40.00 C 40.03 C 37.63 2.40 C 1 1 8/24/94
The calibration values obtained above are traceable to the National Institute for Standards and Technology
Tested with
Hart Scientific Model: 9105
Serial No: 8249105
Calibration Date: 5/ 5/94
Transition Temperature:
Recalibration Date: 5/ 5/95
Hart Scientific Model: 9123
Serial No. 8249123
Calibration Date: 1/ 1/94
Transition Temperature: 35.00 C
Recalibration Date: 1/ 1/95
Hart Scientific Model: Thermometer
Serial No: 824Therm
Calibration Date: 2/ 2/94
Recalibration Date: 2/ 2/95
Notes: Testing 2 drywell configuration with ADIB60 chip and transition temperature.
Calibrated by

Calibration reports are automatically generated for printing immediately and are stored for printing or re-printing at a later time.



The 1531's signal conditioning circuit reads your sensor and sends it's readings to your PC. It also switches the RS-232 signals so you only need one RS-232 port on your PC to run two dry-wells and the 1531.

Ordering Information:

9931 Individual Sensor Calibration System (includes 1531 Dry-Well Interface Thermometer and cables)	**$1,490**
9105 Low Temp Dry-Well –25°C to 140°C (–13°F to 284°F)	**4,995**
9123 High Speed Dry-Well 35°C to 600°C (95°F to 1112°F)	**4,695**
9122 High Capacity Dry-Well 35°C to 600°C (95°F to 1112°F)	**5,495**

SURFACE DRY-WELL — Range: 35°C to 199.9°C

Surface Dry-Well	Model 9125
Handles any surface sensor	
Uniform temperature on test surface	
Reference thermometer well for increased accuracy	
Certificate of traceability to NIST	

Are you tired of using a hot plate with a mechanical switch that gives you a calibration temperature that's almost the one you wanted for calibrating surface temperature sensing devices? The Hart Model 9125 Surface Dry-Well will solve your problems.

Surface probes, thermistors, thin film sensors, RTDs, thermocouples, ribbon sensors and surface mount cutouts, fuses and switches are all easy to calibrate within ±0.2°C using the Hart 9125.

The test surface is milled aluminum for an absolutely smooth and true calibration work area with maximum thermal conductivity. In addition, it is nickel plated for enduring quality and best surface contact with your sensors. The 12.25 square-inch test surface is perfect for calibrating several sensors at once.

Like all Hart dry-wells, the 9125 is carefully tested and individually adjusted to meet all of Hart's exacting specifications.

Hart's Surface Dry-Well isn't just a good idea, it's a truly professional calibration tool.

Specifications — Model 9125

Range:

°C Version: 35°C to 199.9°C

°F Version: 95°F to 400°F

Stability: ±0.1°C

Resolution: 0.1°C, 1°F

Accuracy: ±0.5°C traceable to NIST

Controller: Microprocessor-based PID digital controller, displays actual and set temperatures

Temperature Setting: Digital with pushbutton data entry

Cooling: Built-in cooling fan

Stabilization: Approx. 10 min

Test Surface: Nickel plated aluminum, 3.5 inches square (89 mm)

Uniformity: Within 2.5 inches square (64 mm^2), ±0.2°C; within 3.5 inches square (89 mm^2), ±0.4°C

Reference Well: Thermometer test well accessible at the front of the surface test plate for optional use with a calibrated reference probe (.187" dia)

Size: 4″ H x 7.5″ W x 10″ D (102 mm x 191 mm x 254 mm)

Power: 120 VAC (240 VAC optional, add "-E" to the model number.)

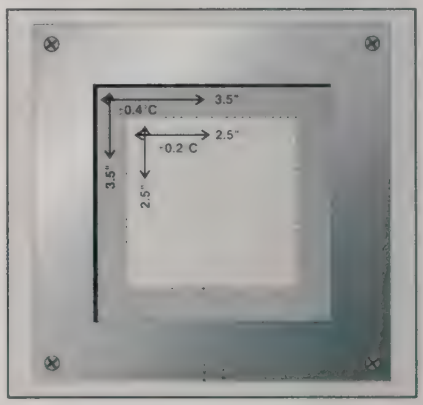
Weight: 7 lbs (3.2 kg)

Carrying Case: Optional, ABS foam case with O-ring, water-tight closing. Foam interior protects surface calibrator and accessories.

Calibration Certificate: Included, with data. States compliance and traceability to NIST standards.

Ordering Information:

9125C Surface Dry-Well °C	**$2,250**
9125F Surface Dry-Well °F	**2,250**
9301 Rugged Carrying Case	**155**



Uniformity of the Test Surface.

INFRARED CALIBRATOR — Range: 35°C to 199.9°C

Infrared Calibrator	Model 9130
Instant verification of IR thermometer accuracy	
Certified traceable to NIST	
Lightweight yet rugged for portability	
Quick and uncomplicated operation	

If you've got an infrared thermometer, then you know IR sensors need frequent accuracy checks. When IRs need calibration, they can't be calibrated conventionally like thermocouples, RTDs and other sensors. You need a special IR sensor calibrator. The Hart Model 9130 handles almost any type of infrared thermometer.

Simply point your IR thermometer at the Model 9130's calibration target and adjust your IR unit to the digital readout on the calibrator. You get a NIST traceable reading of the target temperature within ±0.5°C.

The specially machined concentric rings in the calibration target, or "blackbody," reduce surface reflectance and assure a true temperature reading. A high emissivity coating is baked on the target to give accurate calibration of your IR thermometer. Emissivity of 0.95 is within the range of all adjustable IR meters.

A custom etched-film heater produces the required calibration temperature and is controlled by a high grade platinum RTD sensor embedded behind the front surface of the target. The digital controller and the platinum sensor are system calibrated in Hart's lab to assure NIST traceable accuracy in your calibrator. A thermometer reference well is drilled into the target block for an optional standards thermometer if increased accuracy is needed. With a block stability as high as ±0.1°C, precision calibrations are easy to do.

Temperature setpoint changes are easy, and temperature stabilization occurs within ten minutes. This seven pound calibrator is easy to take practically anywhere for on-site calibrations.

Any instrument service shop or calibration lab benefits from an excellent calibration tool like this one. Maintain your industrial IR thermometers and sensors using the newest and best IR calibration instrument available.

Specifications — Model 9130

Range:

°C Version: 35°C to 199.9°C

°F Version: 95°F to 400°F

Stability: ±0.1°C

Accuracy: ±0.5°C

Controller: Microprocessor-based PID digital controller. Displays actual and set temperatures.

Temperature Setting: Digital with pushbutton data entry

Cooling: Built-in cooling fan

Stabilization: Approx. 10 min

Target Size: 2.25 inches (63.5 mm) dia

Emissivity: 0.95

Reference Well: Test well drilled in the test target for verification of calibrator accuracy using a standards probe.

Size: 3.5" H x 7.5" W x 10" D (89 mm x 191 mm x 254 mm)

Power: 120 VAC (240 VAC optional, add "-E" to the model number.)

Weight: 7 lbs (3.2 kg)

Carrying Case: Optional, ABS tough foam case with O-ring

Calibration Certificate: Included, with data. States compliance and traceability to NIST standards.

Ordering Information:

9130C Infrared Calibrator °C	**$2,295**
9130F Infrared Calibratior °F	**2,295**
9301 Rugged Carrying Case	**155**

PORTABLE CALIBRATION FURNACE

Portable Calibration Furnace	Model 9113
Temperatures to 1100°C	
Optional computer interface for automated calibration	
Rapid heating and stabilization times	
Stability ±0.75°C or better	

Hart's portable calibration furnace does full-range calibrations on thermocouples up to 1100°C. The Model 9113 gives you fast, simple and accurate calibrations with almost twice the temperature range of other dry-well calibrators. Best of all. this instrument is portable for on-site calibration work and is inexpensive considering its level of performance.

A sophisticated yet easy-to-operate digital controller sets and displays the furnace temperature. Heating and stabilization times are among the shortest in the industry.

Advanced design techniques protect the internal controls from high temperatures and make the furnace safe to operate in almost any environment, and unlike sand baths, the Hart furnace does not pollute your lab with dust and other airborne particles.

The special alloy block inserts provide uniform calibrations at higher temperatures. Each insert features a reference hole to receive a standards probe (external reference thermometer) for more accurate comparison calibrations.

The 9113 comes with one insert with two holes. One fits the typical diameter of a reference thermocouple like Hart's (0.28"). The other is drilled for the popular 0.25" diameter probes used in industry. Additional inserts drilled to your specifications are available.

Each 9113 is shipped with a certificate giving actual display values and error at 500°C and 1000°C. Typical accuracy of the built-in display is ±5°C. However, the 9113 is designed to provide the most stable and uniform environment available in this price range for comparison calibrations using an external reference thermometer. Calibrated type S thermocouples are available from Hart on page 48 of this catalog. With the right reference thermometer, the 9113 can give you calibration error less than 1 or 2 degrees at 1100°C.

Its small size and weight of only 22 pounds make it excellent for field work or mobile calibration labs.

Compare the price of this portable calibration furnace to other less capable instruments, and you'll buy it.

Specifications	Model 9113

Range: 200°C to 1100°C (392°F to 2012°F)

Stability: ±0.75°C

Display Resolution: 1°C

Display Accuracy: 5°C

Test Well: 1.3" (33 mm) dia. x 10.5" (266.7 mm) D, quartz lined. Available inserts size the well for best thermal contact with the probe.

Inserts: Special high temperature alloy. Standard inserts include a reference hole and a test hole. One insert is included with the 9113 with 1 hole for 0.25" (6.35 mm) dia. probes and one for a 0.28" (7.1 mm) dia. standard. Additional custom drilled inserts are available with hole sizes starting at .187" (4.76 mm) [fit]. Insert block dimension is 1.25" dia. x 6" long (31.75 mm x 152.4 mm).

Interface: Optional, RS-232 serial interface for computer controlled operation

Cooling: Built-in fan keeps enclosure cool and assists cool-down after high temp use.

Power: 120 VAC, 60 Hz (240 VAC 50 Hz optional, add "-E" to the model number)

Size: 17.5" H x 13" W x 7" D (445 mm x 330 mm x 178 mm)

Weight: 22 lbs (10 kg)

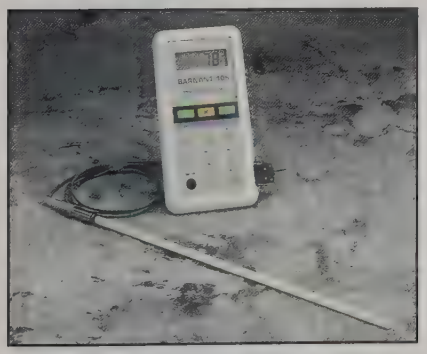
Carrying Case: Optional, protects the furnace in transport

Calibration Certificate: Included, provides actual data at 500°C and 1000°C giving error of the built-in display and stability data

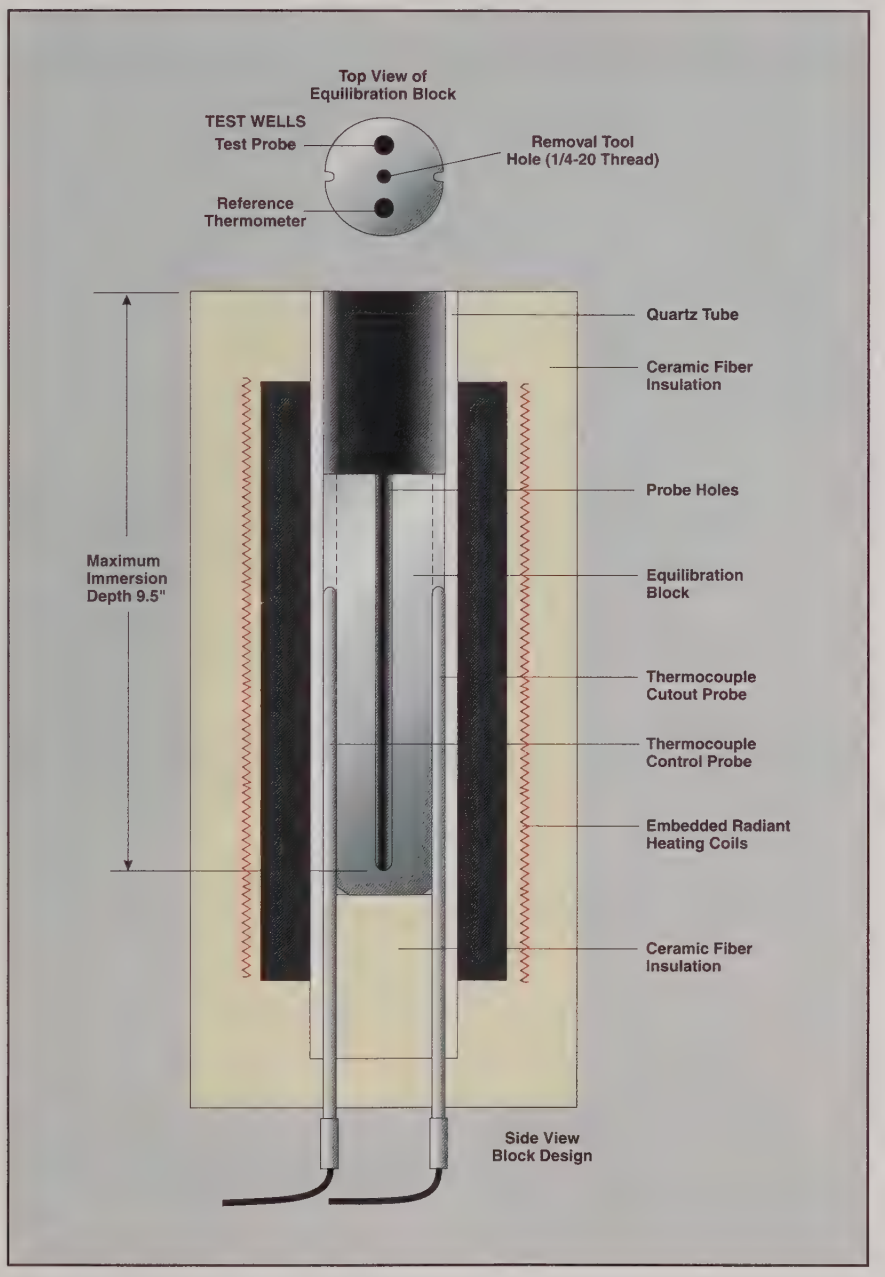
Ordering Information:

9113 Portable Calibration Furnace	**$5,295**
2123 RS-232 Interface Option	**395**
2124 Additional Insert (Specify Hole Dia)	**900**
9302 Carrying Case	**230**

See our complete line of carrying cases on page 144.



Use this calibrated meter and probe with your 9113 as an external reference thermometer (see page 54).



CALIBRATION FURNACE

Calibration Furnace	Model 9112
Stringent industry leading specs	
Priced 30% lower than comparable furnaces	
RS-232 interface standard	
Simultaneously calibrates multiple probes	

Hart Scientific engineered the Model 9112 Calibration Furnace for the most stringent requirements of thermocouple and RTD calibrations at high temperatures. Several unique design features are used to achieve stability of ±0.1°C at 1100°C and ±0.05°C at 500°C and lower. No other commercial furnace reaches this level of performance at a similar price.

Alternative calibration tools such as a sand bath or fluidized alumina bath have been used for calibrations up to 700°C but with very poor comparative performance. Gradients of several degrees are common in a sand bath, along with poor stability, resulting in low accuracy calibrations. Sand baths are also known to create a troublesome dust problem. Why buy poor performance and lab pollution?

Calibration furnaces are an excellent alternative to sand baths, but other manufacturers charge up to $18,000 for units having high temperature stability of only ±0.25°C or worse. In addition, most designs limit the size and shape of sensors that can be accommodated. Longer heating/cooling rates and stabilization times are due to larger and slower isothermal block assemblies.

Unique Engineering

The design of Hart's furnace core is chiefly responsible for its superior performance while keeping its base price just under $12,000. The 9112 employs a special heater pattern for temperature uniformity and rapid heat rates. The heaters are embedded in a refractory ceramic fiber type material forming a two-piece heating assembly. A quartz tube lines the entire test zone of the furnace, insulating the isothermal block and your work from the high power heater windings, while supporting the isothermal block and further equalizing temperature distribution. The entire core assembly is modular and can be disassembled and serviced by competent technicians. Spare replacement parts for all major components are affordable and readily available from Hart customer service.

The isothermal block assembly is machined from a high nickel content alloy for good thermal conductivity and resistance to high temperature oxidation. The central block itself is sized for optimum balance between sufficient mass for good stability/uniformity and small enough mass for rapid heating/cooling and stabilization. The assembly makes use of two smaller alloy blocks as thermal barriers and heat sinks. Guide tubes connect the blocks and guide your probes to the heart of the block for calibration. A thermal shield at the front of the assembly assists in preventing heat loss at the front of the furnace.

Multiple Probe Calibrations

The standard furnace block accepts up to four probes under test and one standard or reference probe. The four test holes take ¼-inch diameter probes and the reference hole accepts the slightly larger and typical standard type S thermocouple or an SPRT. The standard block accommodates probes 12 inches or greater in length. Shorter probes are calibrated by placing the tip of the standards thermometer at the same depth or by ordering a custom-sized assembly to accept your special probes. Custom isothermal blocks can handle a specific number of probes with different diameters and different depths. Call our sales department for a custom quote.

Microprocessor Control

A microprocessor-based digital temperature controller makes setpoint adjustments fast and easy. Both set and actual temperatures are simultaneously displayed for your convenience. A fast pushbutton adjustment is used for manual temperature settings. The controller is factory tuned for best performance between 300°C and 1100°C where the tuning function is set for automatic conformity to the setpoint requirements. When using the furnace below 300°C, controller adjustments are made to achieve high stability.

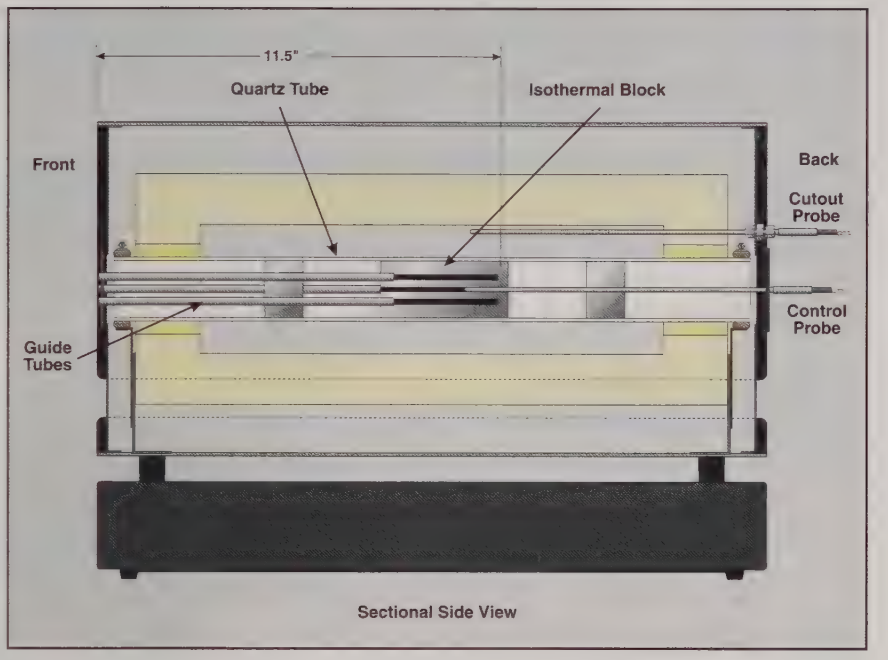
The isothermal block design and the controller autotuning combine to give you metrology level performance. The block delivers uniformity of ±0.05°C at the low end and ±0.3°C or better at the high temperature end. The stability figures quoted in our specification table are for mid- to long-term stability. Short-term stability during a comparison calibration is even better.

Automated calibration systems are easily built around the 9112 furnace. The standard RS-232 interface for computer control allows a custom system to calibrate several probes simultaneously and record the results on a computer while the 9112 automatically steps through preselected temperatures per the customer's computer program.

Built-in Safety

A user-setable safety thermostat prevents over-temp accidents. This cutout control uses a separate thermocouple probe for redundant assurance. Both the control and the cutout probes are changeable at the back panel of the furnace for quick replacement. Down time due to a shorted or intermittent control probe is eliminated.

Hart's engineers provided a special cabinet design that isolates the control electronics and wiring from the heated furnace enclosure. The cabinet ventilation system makes use of thermostatted cooling fans to assure that the cabinet surfaces are cool to the touch. The benchtop design reduces the amount of lab space required while making it easy to place probes into and out of the furnace.



Sectional Side View

Wide-range and high-temperature calibration work is now easier and more affordable due to Hart's innovative 9112 design. Thermocouples, RTDs, optical fiber probes, and other special sensors or materials are all tested or calibrated with a greater level of confidence and accuracy.

Specifications	Model 9112
Stability:	300°C ±0.05°C
	500°C ±0.05°C
	700°C ±0.1°C
	1000°C ±0.1°C
	1100°C ±0.1°C
Uniformity:	300°C ±0.05°C
	500°C ±0.08°C
	700°C ±0.2°C
	1000°C ±0.25°C
	1100°C ±0.3°C

Heating Rates: 700°C to 900°C, 145°C/hour on low; 900°C to 1000°C, 370°C/hour on high

Cooling Rates: Nominal @800°C ≥ 300°C/hour, Nominal @600°C ≥ 180°C/hour

Stabilization Time: Typically 2 hours midrange, slower at low temperature end (4 hours), faster at high temperature end. May be used sooner or later depending on results needed.

Interface: RS-232 included on all units

Outside Dimensions: 18" H x 14.25" W x 26" D (457 mm x 362 mm x 660 mm)

Weight: 72.5 pounds (33 kg) complete [63.5 pounds (28.8 kg) w/o block]

Power: 208–240 VAC, 50/60 Hz, 15 A max. power

Heater: 3700 Watts High, 925 Watts Low

Ordering Information:

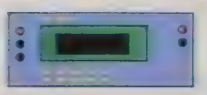
9112 Calibration Furnace	**$11,795**
Custom Blocks	**Call**

INTRODUCTION TO THE BEST OF THE REST

We're constantly looking for new or interesting products to put in the catalog. We've used almost all of the products in this section, and we like them. Try them yourself and let us know what you think.

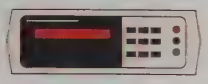
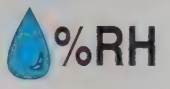
We carry high resolution digital multimeters, precision resistance standards, thermocouple and RTD simulators, humidity/temperature recorders for your lab, humidity calibrators, some interesting new software and some of the best instrument carrying cases available.

Simulators

	Model	Accuracy†	TCs	RTDs	Features	Price	Page
	5126 Precision RTD Simulator	±0.02%		20 to 1120Ω	0.01Ω resolution Affordable Small compact design	$950	122
	5125 Standards Lab RTD Simulator	±0.005%		10 to 1111.11Ω	Best RTD simulator ±0.001Ω resolution	2,595	123
	5124 RTD Simulator	±0.01%		10 to 1111.11Ω	Lower cost No "O" resistance	1,795	
	5123 RTD Simulator	±0.005%		100 to 1111.11Ω	High accuracy Six decades	1,785	
	Handheld Temperature Simulator Kits						
	5129	±1.1°C ±2°F	K,J,T		Small handheld design Degrees C or F	720	124
	5143	±0.3°C ±0.5°F	K,J,T,E		10 memory storage	825	
	5144	±0.3°C ±0.5°F	K,J,T,E,N,B,R, S,C,D,G		Most TC types Battery powered	1,129	
	5152	±0.3°C ±0.5°F	K,J,T,E	Pt100Ω 0 to 1000Ω	Three-year warranty TCs and resistance	1,129	
	5153	±0.3°C ±0.5°F	K,J,T,E,N,B,R, S,C,D,G	Pt100 0 to 1000Ω	Most sensor types 0.1 degree resolution	1,350	
	5161 Professional Handheld Simulator	±0.3°C ±0.54°F	K,J,T,E,N,B,R, SW5/W26	Pt100	Three memory output storage Patented connector	1,900	126
	5131 Universal Temperature Calibrator	±0.25°C ±0.45°F	K,J,T,E,N,B,R, S,C,U,L	Pt100, Pt200, Pt500, Pt1000, Ni100	Ramping Functions Language selectable menu system Voltage and Current measurements	2,950	128
	5160 Precision Multi-Function Simulator	±0.13°C ±0.23°F	J,K,T,E,N,R,S, B,C,U,L,F,G	Pt100, Pt200, Pt500, Pt1000, Ni100, Ni120, Cu10, Cu100	20 setpoint ramp functions Graphic LCD display RS-232 included Volts, Amps, Hz	3,150	130
	5135 Standards Lab Thermocouple Simulator	±0.02°C ±0.036°F	K,J,T,E,N,B,R, S		Best accuracy Rechargeable battery Volts, amps RS-232 and IEEE-488 options	$3,195	132

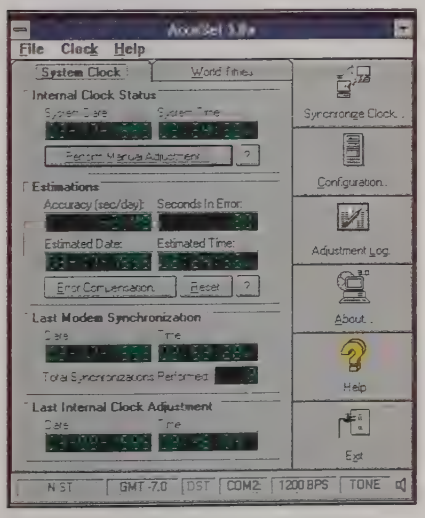
†Accuracy stated at 500°C for comparison

AND THERE'S MORE

	Product	Description	Price	Page
	Digital Multimeters	High resolution, high accuracy models, 6½ to 8½ digits See index on page 135	From $995	134
	Model 5100 HumiCalc Software Model 5109 Model 5110	Low-cost, wall-mount thermohygrometer Performs complex humidity calculations and conversions Lab Humidity/Temperature Recorder Relative Humidity Calibrator	49 99 650 2,549	138 138 139 140
	Air Resistors	Values from 1Ω to 10MΩ Accuracy to 1ppm, stability to 4ppm	1,389	141
	Cal-Pro 9000	Asset Management Software Tracks calibration, repair, recalls, plus...	500	143
	Instrument Cases	Several models to fit Hart and other instruments	45– 350	144
	Q90 Standards	ISO-9000 Standards Published by ANSI/ASQC, includes ISO 9000, ISO 9001, ISO 9002, ISO 9003 and ISO 9004	$85	142

PC Clock Syncronization Software

Every order from this catalog valued over $1,000 will receive a copy of a Windows™ based time synchronization program. This clever program allows your PC's modem to call NIST in Boulder Colorado and then synchronizes your PC's clock to the atomic clock. Use it to get all your wall clocks and watches set to the correct time. If you need a serious time standard this isn't it, but it's still fun and quite useful. This is shareware, so if you like it you should register it by sending $10 to the author listed in the program and you'll get free updates. Due to commercial license agreements we can not do this for you.



FREE!

1-year subscription to Cal Lab magazine

The first 100 orders from this catalog valued over $5,000 will receive a free 1-year subscription to Cal Lab magazine ($70 value, Domestic Subscription only.) Good magazine—great gift.

PRECISION RTD SIMULATOR — Range: 20 to 1120 Ohms

Precision RTD Simulator	Model 5126
Waidner-Wolf shunt design	
±0.02% accuracy over its entire range	
Small size	
Durable construction	

If you've been looking at the Hart Model 5125 RTD Simulator on page 123 with the Waidner-Wolf shunt decade design for "no adder accuracy," but the accuracy and price are beyond your present needs, you should consider the Hart Model 5126 RTD Simulator.

The 5126 is a shunt decade design with ±0.02% accuracy over its entire range of 20 to 1120 ohms. It is often more accurate than the ±0.01% basic accuracy advertised on other decade units. This is because the 5126's overall accuracy statement of ±0.02% is absolute and includes all "O" resistance and contact resistance inaccuracies.

Its digital thumbwheel setting is easy to read and easy to operate. It handles any RTD in this temperature-equivalent resistance range and isn't limited like fixed resistance simulators to only one type of RTD.

The Model 5126 RTD Simulator has 5 decades and a resolution of 0.01 ohms. It's 3 x 5 x 4 inches and is built to last. The thumbwheel switches are rated for more than 50,000 turns between failures. That's a lifetime of use.

Hart's complete line of RTD simulators begins and ends with the best.

Don't waste your time with advertising claims that bend specs or promise performance you won't see in the lab!

Specifications — Model 5126

Range: 20 to 1120 ohms

Resolution: 0.01Ω

Absolute Accuracy: ±0.02%

Maximum Current:
20 to 99.99 50 mA
100.00 and up 15 mA

Switch Life Rating: >50,000

Resistor Tempco: 3 ppm/°C typical
5 ppm/°C max

Resistor Stability: ±10 ppm/24 hrs; ±35 ppm/yr.

Maximum Power: 100 milliwatts

Breakdown Voltage: 750 VRMS

Operating Temperature: –55°C to 75°C

Dimensions: 3" H x 5" W x 4" D (76 mm x 127 mm x 102 mm)

Ordering Information:

5126 RTD Simulator **$950**

Phone: 800 438-4278
Fax: 801 785-7118

STANDARDS LAB RTD SIMULATOR — Range: 10 to 1111.11 Ohms

Standards Lab RTD Simulator	Model 5125
Best RTD simulator available	
Fully adjustable in 0.001 ohm increments	
Handles all RTD simulation needs	

Do you want the highest accuracy RTD simulator available? The Hart Model 5125 has absolute accuracy of ±0.005% over its entire resistance range and is suitable for standards lab work.

There is no need to calculate or compensate for the error contribution due to contact resistance or "O" resistance because there is no "O" resistance. The unique shunt decade design (Waidner-Wolf) reduces these errors to a level of insignificance.

When the Model 5125 replaces the RTD in the system, any temperature-equivalent resistance can be selected on the error-free readout dials. With one milliohm resolution (lowest decade), it is possible to check or calibrate all of the other elements in the system.

The "no adder accuracy" design makes the 5125 a recognized industry standard for the test, analysis and calibration of virtually any RTD system or readout.

For use with the newer, higher accuracy 1000 ohm platinum RTDs, order Hart Model 5123 with 100 to 11,111.10 ohms range and 0.01 ohms resolution. If you need the range of 10 to 1111.10 ohms but prefer a lower cost, lower accuracy simulator, ±0.01% absolute accuracy, choose the Model 5124.

Specifications — Model 5125

Resistance Range: 10 ohms to 1111.11 ohms

Number of Decades: 6

Resolution: 0.001 ohm

Absolute Accuracy of Setting: ±0.005%

Maximum Current for Rated Accuracy: 10 to 100 ohm, 75 mA; 100 ohm and up, 25 mA

Switch Life Rating: >100,000 avg

Resistor Temp Coef: 3 ppm/°C typical, 5 ppm max

Resistor Stability: ±10 ppm/24 hrs., ±35 ppm/1 yr

Maximum Power Rating: 100 milliwatts

Breakdown Voltage: 750 VRMS

Operating Temperature: –55°C to 75°C

Dimensions: 4" H x 17" W x 3.12" D (102 mm x 432 mm x 79 mm)

Ordering Information:

5125 RTD Simulator, ±0.005%	**$2,595**
5124 RTD Simulator, ±0.01%	**1,795**
5123 RTD Simulator, ±0.005%, 100 to 11,111 ohms, 0.01ohms resolution, for use with 1000 ohm RTDs.	**1,785**

HANDHELD TEMPERATURE SIMULATOR KITS

Thermocouple & RTD Simulators	Tegam Series
Priced right	
Field tough	
Lightweight (only 12 oz)	
Calibration kit included	

Because of their popularity, Hart again is offering the Tegam handheld simulators. Use these handy instruments to calibrate your thermocouples and RTD readout devices or use as a digital thermometer to check your probes.

This year we have included the calibration kits with the meters for better adaptability to your application. You now get a complete portable calibration instrument with all the features you need for your field work.

The Hart/Tegam units are the best quality thermocouple calibrators available for field work. They weigh only 12 oz and can fit in your shirt pocket. The 5129 (K, J, T) gives ±0.1% accuracy. With ±0.5°F accuracy and full range resolution of 0.1 degrees in F or C on the new models, nothing beats this calibrator series in price and performance.

Each model features a five-digit display and direct entry of setpoints from the keypad. Store up to ten of your most often used simulation values in memory for quick recall. Competitive units either don't offer memory or are limited to only three memory values. The power conserving microprocessor design of the Tegam series gives you 50 hours of battery life versus the common portable instrument battery life of eight to ten hours.

Each calibrator comes with a complete accessory kit. You can calibrate temperature controllers, recorders, process monitors, panel meters and transmitters, whether they're equipped with standard jacks, with sub-miniature jacks or with screw terminals. You also get a rugged, foam filled carrying case, a coiled calibration cable, an AC adapter and rechargeable battery, along with a protective rubber boot and belt clip.

Each unit also features a thermometer mode for general temperature measurements. The ten-position memory stack stores your last ten temperature measurements for review at your convenience. The thermometer mode makes these calibrators a good companion to a Hart Dry-Well Calibrator. In addition to calibrating your electronics, the Tegam units can be used to accurately read the output from the thermocouples or RTDs that you calibrate in the dry-well.

Choose the 5129 for basic J, K and T thermocouple work or any one of the other simulators for a broader selection of sensor simulations. In addition to our industry leading three-year warranty, every one of these instruments comes with a two-year guarantee on the calibration accuracy of the simulator. Our quoted accuracy isn't short term. You need reliable precision, and we're ready to backup our specification claims.

A three-year warranty, a NIST traceable certificate of calibration and a great price. What every field-use thermocouple simulator should have!

Model 5129 Thermocouple

The standard model offers types K, J and T for the most common thermocouple work. Accuracy is slightly less than the other models, but the price makes this a great general purpose unit.

Model 5143 Thermocouple

This model gives you K, J, T and E thermocouples plus improved accuracy. Type E is a common thermocouple in some industries and in research, so this may be your best choice.

Model 5144 Thermocouple

This model includes eleven thermocouple types: K, J, T, E, N, B, R, S, C, D and G. With this unit you're prepared for virtually any thermocouple simulation requirement. Type N is gaining in popularity, and types B, R and S are very common in high temperature industrial applications.

Model 5152 Thermocouple, RTD & Ohms

Simulate the popular K, J, T and E types plus the commonly used 100Ω RTD. Enter your temperature directly in degrees, and the 5152 outputs the correct resistance to simulate an RTD with the "385" Alpha. On the ohms range, you can enter resistance directly between 0 and 1000 ohms for simulation of other RTD types.

Model 5153 Thermocouple, RTD and Ohms

This unit is top-of-the-line. It comes with all the functions and all of the sensors listed above—all thermocouples, 100Ω RTDs, and resistance from 0 to 1000 ohms. If you're having a hard time choosing sensor types, just get this one. You'll be ready for almost anything.

Specifications

Ranges:

K –200°C to 1372°C (–328°F to 2502°F)
J –210°C to 760°C (–346°F to 1400°F)
T –200°C to 400°C (–328°F to 752°F)
E –200°C to 1000°C (-328°F to 1832°F)
N –200°C to 1300°C (–328°F to 2372°F)
B 0°C to 1700°C (32°F to 3092°F)
R 0°C to 1450°C (32°F to 2642°F)
S 0°C to 1450°C (32°F to 2642°F)
C 0°C to 2320°C (32°F to 4208°F)
D 0°C to 2320°C (32°F to 4208°F)
G 0°C to 2320°C (32°F to 4208°F)
RTD –200°C to 850°C (–328°F to 1562°F) 100Ω Pt., "385" Alpha

Resistance: 0 to 1000Ω

Accuracy:
Model 5129: ±0.1% + 0.6°C or 1.0°F
All other Models: > –50°F (±0.5°F); ≤ –50°F (±1.0°F)

Repeatability: ±0.2°C

Display Digits: 5 fields, °C and °F

Resolution:
TCs: 0.1 degree
RTDs: 0.1 degree
Ohms: 0.01 ohm

Input Method: Push Button

Output Memory Locations: 10

Power: 9V battery or AC adapter

Size: 7" H x 2.9" W x 1.1" D (179 mm x 74 mm x 28 mm)

Weight: 12 oz (340 grams)

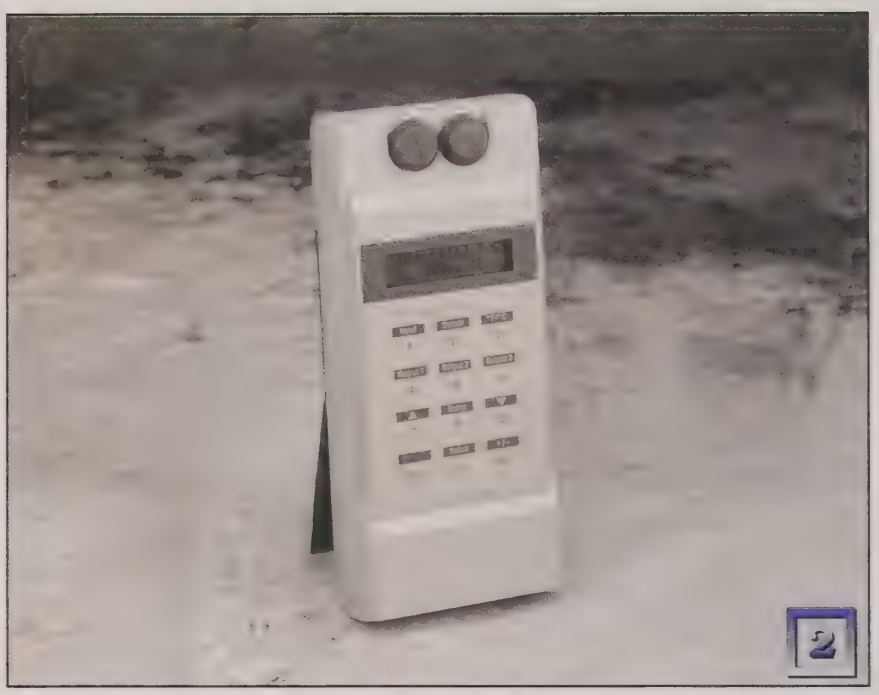
Operating Range: 0°C to 50°C

Ordering Information:

Model #	TC Types	RTDs	Ohms	Price
5129	K, J, T	N/A	N/A	**$ 720**
5143	K, J, T, E	N/A	N/A	**825**
5144	K, J, T, E, N, B, R, S, C, D, G	N/A	N/A	**1,129**
5152	K, J, T, E	100Ω	0 to 1000Ωs	**1,129**
5153	K, J, T, E, N, B, R, S, C, D, G	100Ω	0 to 1000Ωs	**1,350**

Each kit includes: Simulator, connectors, cables, adapters, type K probe, 9 V battery, AC adapter, rubber boot and attaché case.

PROFESSIONAL HANDHELD SIMULATOR



Professional Handhled Simulator	Model 5161
Lab-grade accuracy	
Simulates and reads all thermocouples and 100Ω RTDs	
Unique easy-to-use patented connector	
Lightweight and rugged	

If you want a compact handheld simulator but you need 0.1°C accuracy, the Hart Model 5161 Professional Handheld Simulator meets your needs. It reads or outputs all thermocouple types and 100 Ohm RTDs and it's easy to use and field ready.

Program all functions—including sensor selection, inputs and outputs, ramp setting and error recognition using the front panel push buttons. The LCD display prompts you through all settings so you don't have to memorize complex instructions or carry manuals with you in the field. Temperature readout is selectable in either °C or °F as well as in millivolts or ohms.

This unit features Thermo Electric's patented Omnicon connector that accepts virtually any style connector. Isothermally it provides excellent, near perfect, reference junction compensation. The Model 5161 recalibrates itself every 15 seconds to compensate for drift.

Power is supplied by either 6 AA batteries or through the AC adapter. Carry it where you need it and don't worry about plugging it in. Hart's Model 5161 stores three memory outputs. Ramp through a series of set points or select them individually. The Model 5161 serves as a thermometer to check your probe and as a simulator to check your readout device. One unit checks both if used with a dry-well (see page 98).

Each instrument is guaranteed for two years, and is shipped with a NIST traceable certificate of calibration.

Specifications

Input and Output Types:

Thermocouples: J, K, T, E, N, W5/W26, Platinell II, R, S, and B

RTDs: 100Ω Platinum, 385 Alpha

Accuracy: See table opposite page

Stability: 15 ppm of reading/°C

Resolution: 0.1°

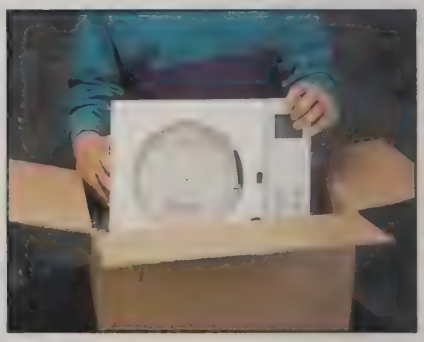
Power Supply: 6 "AA" batteries or AC adapter

Size: 8.6" H x 3.75" W x 2.4" D

Weight: 28 oz

Ordering Information:

5161 Simulator	**$1,900**



Tina manages distributed products. She's packing this one just for you.

ISA Calibration	Available Range	Resolution	Accuracy Ranges(s)	Typical Error @32°F(0°C)	@ 90% of Span	Worst Case Error[1]
J[2]	–346.0 to 2192.0°F	0.1°F	–346.0 to 2192.0°F	±0.0°F	±0.1°F	±0.5°F
	210.0 to 1200.0°C	0.1°C	–210.0 to 1200.0°C	±0.0°C	±0.0°C	±0.3°C
K[2]	–382.0 to 2500.0°F	0.1°F	–382.0 to 310.0°F	±0.5°F (@–382.0°F)	NA	±1.0°F
			–310.0 to 2500.0°F	±0.0°F	±0.1°F	±0.5°F
	–194.4 to 1371.1°C	0.1°C	–194.4 to –190.0°C	±0.3°C (@-194.4°C)	NA	±0.6°C
			–190.0 to 1371.1°C	±0.0°C	±0.0°C	±0.3°C
T[2]	–340.0 to 752.0°F	0.1°F	–340.0 to 752.0°F	±0.0°F	±0.1°F	±0.5°F
	–206.7 to 400.0°C	0.1°C	–206.7 to 400.0°C	±0.0°C	±0.0°C	±0.3°C
E[2]	–320.0 to 1832.0°F	0.1°F	–320.0 to 1832.0°F	±0.0°F	±0.1°F	±0.5°F
	–195.6 to 1000°C	0.1°C	–195.6 to 1000.0°C	±0.0°C	±0.0°C	±0.3°C
N[3]	32.0 to 2372.0°F	0.1°F	32.0 to 2372.0°F	±0.0°F	±0.1°F	±0.5°F
	0.0 to 1300.0°C	0.1°C	0.0 to 1300.0°C	±0.0°C	±0.0°C	±0.3°C
W5/W26[4]	32.0 to 4200.0°F	0.1°F	32.0 to 4200.0°F	±0.2°F	±0.3°F	±0.7°F
	0.0 to 2315.6°C	0.1°C	0.0 to 2315.6°C	æ0.1°C	±0.2°C	±0.4°C
Platinel II[5]	–140.0 to 2543.0°F	0.1°F	–140.0 to 2543.0°F	±0.0°F	±0.1°F	±0.5°F
	–95.5 to 1395.0°C	0.1°C	–95.5 to 1395.0°C	±0.0°C	±0.0°C	±0.3°C
R[2]	0.0 to 3200.0°F	0.1°F	0.0 to 32.0°F	±0.6°F	NA	±2.5°F
			32.0 to 3200.0°F	±0.6°F	±0.8°F	±1.7°F
	–17.8 to 1760.0°C	0.1°C	–17.8 to 0.0°C	±0.4°C	N.A	±1.4°C
			0.0 to 1760.0°C	±0.4°C	±0.5°C	±0.9°C
S[2]	0.0 to 3200.0°F	0.1°F	0.0 to 32.0°F	±0.6°F	N.A	±2.5°F
			32.0 to 3200.0°F	±0.6°F	±0.8°F	±1.7°F
	–17.8 to 1760.0°C	0.1°C	–17.8 to 0.0°C	±0.4°C	NA	±1.4°C
			0.0 to 1760.0°C	±0.4°C	±0.5°C	±0.9°C
B[2]	1000.0 to 3300.0°F	0.1°F	1000.0 to 3300.0°F	NA	±0.8°F	±1.7°F
	537.8 to 1815.6°C	0.1°C	537.8 to 1815.6°C	NA	±0.5°C	±0.9°C
RTD in[6]	–320.0 to 1500.0°F	0.1°F	–320.0 to 1500.0°F	±0.0°F	±0.1°F	±0.5°F
	–195.5 to 815.6°C	0.1°C	–195.5 to 815.6°C	±0.0°C	±0.0°C	±0.3°C
RTD out[6.7]	–320.0 to 1500.0°F	0.1°F	–320.0 to 1500.0°F	±0.1°F	±0.1°F	±0.7°F
	–195.5 to 815.6°C	0.1°C	–195.5 to 815.6°C (typical error @ 1_{ex} = 1.0 mA)	±0.0°C	±0.1°C	±0.4°C
Ohms in	0.00 to 700.00Ω	0.01Ω	0.00 to 700.00Ω	±0.00Ω (@ 0.00Ω)	±0.01Ω	±0.05Ω
Ohms out[7]	0.00 to 400.00Ω	0.01Ω	0.00 to 400.00Ω (typical error @ 1_{ex} = 1.0 mA)	±0.01Ω (0.00Ω)	±0.02Ω	±0.14Ω
mV	–9.999 to 99.999mV	0.001mV	–9.999 to 99.9999mV	±0.001 mV (@0.000mV)	±0.001mV	±0.005mV

[1]At 75°F±5°F within 6 months after calibration
[2]Conformity based on IPTS-68; NBS Monograph 125
[3]Conformity based on NBS Monograph 161 (AWG 14)
[4]Conformity based on Hoskins Manufacturing Co., W5/W26 TC
[5]Conformity based on Engelhard Platinel II TC
[6]100 Ohm @0°C Platinum RTD having an Alpha of 0.00385 with its conformity based on the DIN 43760 standard
[7]With an excitation current between 0.1 MA and 2.0 mA

UNIVERSAL TEMPERATURE CALIBRATOR

Calibrator: Thermocouples, RTDs, mV, V, mA & Ω	Model 5131
Best simulator technology on the market	
Measures and simulates all standard signals	
RS-232 port for PC interface available	
Software included	

For the person wanting one tool for servicing and calibrating process control instrumentation, the Hart Model 5131 Universal Temperature Calibrator handles 2- or 4-wire transmitters, controllers, recorders, indicators and actuators. It measures and simulates all standard signals including voltage, current, resistance, thermocouple and RTD sensors.

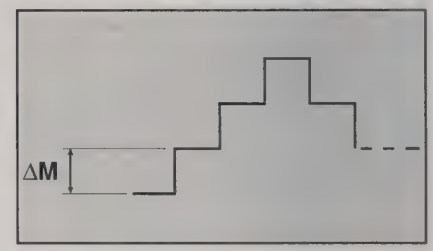
It is a computer interfaceable, programmable unit with 23 functions: mV, V, mA, ohms, couples K, T, J, E, N, U, L, S, R, B, C, RTDs Ni 100 ohms and Pt 100 ohms, 200 ohms, 500 ohms and 1000 ohms.

In addition, the Model 5131 Universal Calibrator has a step generator and a ramp generator, scales in any user selected engineering units, takes relative measurements and has a measurement hold function which can also trigger up to 1000 measurements on request.

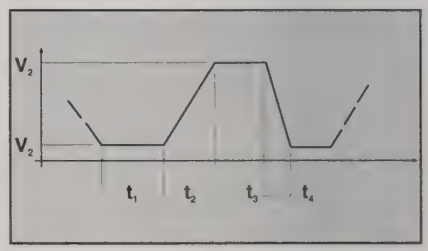
The Universal Calibrator is linkable to your PC through an RS-232 port. Using the Model 5131 software, you can transmit stored values of any group of measurements to your PC, display the stored values as a table or graph, print the graph or table and load the Universal Calibrator with up to 100 simulation values. The on-board memory handles up to 1,000 measurements or 250 bursts with sequence number, function and unit.

The data are recallable by the keypad for display, sendable to your printer or PC or convertible to analog signals (4 to 20 mA or 0 to 1 V). The memory also holds the min, max and average for each burst, along with the sensor type and range.

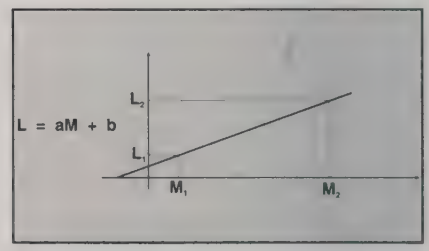
The Universal Temperature Calibrator supplies loop power for current calibration internally or with an external 10 to 24 VDC power supply. It also has a ramp and soak function for checking ramp and soak controllers.



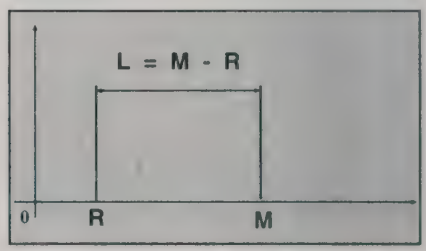
Step Generator.



Ramp Generator.



Scales in any user selected engineering units (input or output).

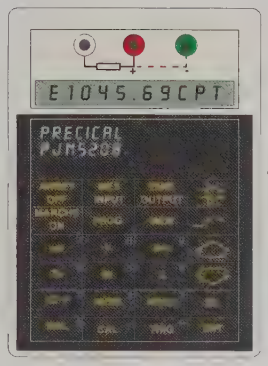


Relative Measurements.

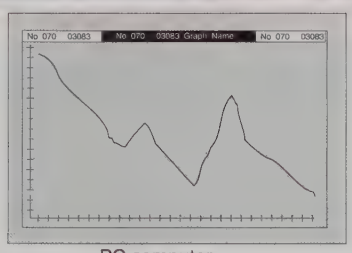
Ordering Information:

5131 Calibrator w/Interface **$2,950**

Includes case, manual and AC adapter.



RS-232



PC computer

```
                                        Salve  -1
0103 mes. Min = 0106.0 May = 0111.7 Max =

000 = 0106.0   001 = 0106.2   002 = 0106.2
005 = 0160.5   006 = 0106.6   007 = 0106.7
010 = 0107.0   011 = 0107.2   012 = 0107.3
015 = 0107.6   016 = 0107.8   017 = 0107.9
020 = 0108.2   021 = 0108.2   022 = 0108.4

025 = 0108.2   026 = 0108.8   027 = 0109.0
030 = 0109.3   031 = 0109.4   032 = 0109.0
035 = 0109.9   036 = 0110.0   037 = 0110.0
040 = 0110.4   041 = 0110.6   042 = 0110.7
045 = 0110.0   046 = 0111.2   047 = 0111.3
```

	Input				Output		
V	**Range**	**Resolution**	**Accuracy**	**Input Impedance**	**Range**	**Resolution**	**Accuracy**
	50 mV	10 µV	0.05% + 1d	> 1000 MΩ	–30 to + 220 mV	1 µV	0.03% + 4 µV
	500 mV	100 µV	0.05% + 1d	> 1000 MΩ	–300 to + 2200 mV	10 µV	0.02% + 20 µV
	5 V	1 mV	0.05% + 1d	1.1 MΩ	– 2 to + 22 V	100 µV	0.02% + 0.2 mV
	50 V	10 mV	0.05% + 1d	1.1 MΩ			
	Series mode rejection > 70 dB at 50 Hz; Common mode rejection > 120 dB DC or AC 50/60 Hz (50 mV range); Common mode voltage < 250 V RMS or 350 V peak				Load resistance ≥ 100 kΩ; Source resistance < 0.2 Ω Output Current ≤ 1 mA (limited to 10 mA in short-circuit) Temperature coefficient < (0.0025% + 0.2)/°C		
I	**Range**	**Resolution**	**Accuracy**	**Voltage Drop**	**Range**	**Resolution**	**Accuracy**
	50 mA	10 µA	0.05% + 1d	< 1.5 V	+0.1 mA to + 24 mA	0.1 µA	0.02% + 0.3 µA
	In current measurement on 2-wire transmitter, the current loop can be powered by an internal source 24 V ± 10% (25 mA max)				Supplies: internally with 24 VDC, for 4-wire circuit; load resistance < 900Ω; externally with 10 to 24 V for 2-wire circuit; load resistance 200 to 900 Ω according to supply		
Ω	**Range**	**Resolution**	**Accuracy**	**Input Current**	**Range**	**Resolution**	**Accuracy**
	500 Ω	0.1 Ω	0.05% + 1d	1 mA	26 to 501 Ω	1 mΩ	0.02% + 10 mΩ
	5000 Ω	1 Ω	0.05% + 1d	0.1 mA	260 to 5010 Ω	10 mΩ	0.02% + 150 mΩ
	Range covered: from 0% to + 120% of range setting; pole voltage in open circuit < 2.5 V Max. resistance permitted ≤ 50 Ω by wire				Current for the stated accuracy: 1 mA (500W range), 0.1 mA (5000W range) Max. current: 30 mA (500Ω range), 10 mA (5000Ω range)		
T/C	**Range**	**Resolution**	**Accuracy**		**Range**	**Resolution**	**Accuracy**
K	–250 to +1370°C	0.1°C	0.05% + 0.2°C		–240 to +1370°C	0.1°C	0.03% + 0.1°C
T	–250 to +400°C	0.1°C	0.05% + 0.2°C		–240 to +400°C	0.1°C	0.03% + 0.1°C
J	–210 to +1020°C	0.1°C	0.05% + 0.2°C		–210 to +1120°C	0.1°C	0.03% + 0.1°C
E	–250 to +775°C	0.1°C	0.05% + 0.2°C		–240 to +1000°C	0.1°C	0.03% + 0.1°C
N	–240 to +1300°C	0.1°C	0.05% + 0.2°C		–240 to +1300°C	0.1°C	0.03% + 0.1°C
U	–200 to +600°C	0.1°C	0.05% + 0.2°C		–200 to +600°C	0.1°C	0.03% + 0.1°C
L	–200 to +900°C	0.1°C	0.05% + 0.2°C		–200 to +900°C	0.1°C	0.03% + 0.1°C
S	–50 to +120°C	1.0°C	0.05% + 0.2°C		–50 to +1770°C	0.1°C	0.05% + 0.5°C
	+120 to +1770°C	0.5°C	0.05% + 1°C			0.1°C	0.05% + 0.5°C
R	–50 to +120°C	1.0°C	0.05% + 2°C		–50 to +1770°C	0.1°C	0.05% + 0.5°C
	+120 to +1770°C	0.5°C	0.05% + 1°C			0.1°C	0.05% + 0.5°C
B	+400 to +900°C	1.0°C	0.05% + 2°C		0 to +1820°C	0.1°C	0.05% + 0.5°C
	+900 to +1820°C	0.5°C	0.05% + 1°C			0.1°C	0.05% + 0.5°C
C	+300 to +1830°C	0.2°C	0.05% + 0.5°C		–20 to +2300°C	0.1°C	0.05% + 0.5°C
	+1830 to +2300°C	0.5°C	0.05% + 1°C			0.1°C	0.05% + 0.5°C
	Measuring resolution and accuracy available for t ≥ –100°C. Precision guaranteed for a reference junction at 0°C. With internal reference junction compensation: add. 0.2°C.						
RTD	**Range**	**Resolution**	**Accuracy**	**Input Current**	**Range**	**Resolution**	**Accuracy**
Pt 100	–220 to +1200°C	0.1°C	0.05% + 0.3°C	1 mA	–180 to +1200°C	0.01°C	0.02% + 0.1°C
Pt 200	–220 to +550°C	0.1°C	0.05% + 0.2°C	1 mA	–210 to +405°C	0.01°C	0.02% + 0.05°C
Pt 500	–220 to +1200°C	0.1°C	0.05% + 0.5°C	0.1 mA	–120 to +1200°C	0.01°C	0.02% + 0.2°C
Pt 1000	–220 to +1200°C	0.1°C	0.05% + 0.3°C	0.1 mA	–180 to +1200°C	0.01°C	0.02% + 0.1°C
Ni 100	–59 to +180°C	0.1°C	0.05% + 0.3°C	1 mA	–60 to +180°C	0.01°C	0.02% + 0.1°C
	Measurement and simulation of RTD Ni 200, 500, and 1000. Specifications on request.						

PRECISION MULTI-FUNCTION SIMULATOR

Precision Multi-Function Simulator	Model 5160
High accuracy thermocouple and RTD simulations	
Large backlit LCD display with 0.01°C resolution	
Field tough—lab precision	

Do you need to calibrate handheld meters or read sensor inputs in the field? Would you like one instrument that reads or simulates every thermocouple type, RTDs: Pt100, 200, 500, 1000 and Ni100, Ni120, Cu10, Cu100, plus DC voltage, current and frequency? The Hart Model 5160, Precision Multi-Function Simulator from Eutron Instruments, does it all in a small 12 pound package.

Both the IPTS 68 and ITS 90 linearizations are built-in. You can ramp through a high and low temperature at average increments or through 20 set points you select. The Model 5160 remembers your programmed set points for easy recall on repetitive work. Use the automatic cold junction compensation in room temperatures from –10°C to 55°C, or switch to external programmable remote cold junction compensation if you desire. Read temperature in degrees C or F on the backlit LCD display.

The Model 5160 has a specially designed chassis to reduce electrical noise in the field and comes with its own leather carrying case. Remember, this package weighs only 12 pounds. That's lighter than your bowling ball, and it's much easier to carry. However, bowling with it does void the warranty.

Want more? It has a real time clock for automatic high accuracy data acquisition, rechargeable NiCad batteries, help screens, a user defined recalibration date with a reminder message, and a communication port for full remote control.

Check the specs. This one does the job when and where you need it done.

Specifications

Input and Output:

Units: mV, V, mA, W, KW

Thermocouples: J, K, T, E, N, R, S, B, C, U, L, F and G

RTDs: Pt100, IEC, OIML, USLAB, US, SAMA, JIS, Pt200, 500, 1000, 1000 OIML, Ni100, Ni120, Cu10, Cu100

Accuracy: See table opposite page

Stability: Full Scale—±5ppm

Interface: RS-232 included

Resolution: TC type T and RTD type Pt100—0.01°C, all others—0.1°C

Power Supply: Internal NiCad rechargeable battery

Weight: 12 lbs

Ordering Information:

5160 Multi-Function Simulator	**$3,150**

The 5160 comes complete with field carrying case for the instrument and cables.

Sensor or Parameter	Total Range	High Accuracy Range	Resolution	Limit of Error (Output)
TC type **J**	–210 to 1200°C	–190 to 1200°C	0.1°C	±(0.007% of Rdg +0.1°C)
TC type **K**	–270 to 1370°C	–160 to 1260°C	0.1°C	±(0.007% of Rdg +0.1°C)
TC type **T**	–270 to 400°C	–130 to 400°C	0.01°C	±(0.007% or Rdg +0.1°C)
TC type **R**	–50 to 1760°C	150 to 1760°C	0.1°C	±(0.007% of Rdg +0.2°C)
TC type **S**	–50 to 1760°C	170 to 1760°C	0.1°C	±(0.007% of Rdg +0.2°C)
TC type **B**	50 to 1820°C	920 to 1820°C	0.1°C	±(0.007% of Rdg +0.3°C)
TC type **C**	0 to 2300°C	0 to 2000°C	0.1°C	±(0.007% of Rdg +0.2°C)
TC type **G**	0 to 2300°C	190 to 2300°C	0.1°C	±(0.007% of Rdg +0.3°C)
TC type **D**	0 to 2300°C	0 to 2130°C	0.1°C	±(0.007% of Rdg +0.3°C)
TC type **U**	–200 to 400°C	–160 to 400°C	0.1°C	±(0.007% of Rdg +0.1°C)
TC type **L**	–200 to 760°C	–200 to 760°C	0.1°C	±(0.007% of Rdg +0.1°C)
TC type **N**	–270 to 1300°C	0 to 1300°C	0.1°C	±(0.007% of Rdg +0.1°C)
TC type **E**	–270 to 1000°C	–200 to 1000°C	0.1°C	±(0.007% of Rdg +0.1°C)
TC type **F**	0 to 1400°C	0 to 1400°C	0.1°C	±(0.007% of Rdg +0.1°C)
Pt 100 IEC	–200 to 850°C	–200 to 850°C	0.01°C	±(0.007% of Rdg +0.05°C)
Pt 100	–200 to 650°C	–200 to 650°C	0.01°C	±(0.007% of Rdg +0.05°C)
Pt 100 JIS	–200 to 600°C	–200 to 600°C	0.01°C	±(0.007% of Rdg +0.05°C)
Pt 200	–200 to 850°C	–200 to 850°C	0.1°C	±(0.007% of Rdg +0.15°C)
Pt 500	–200 to 850°C	–200 to 530°C	0.1°C	±(0.007% of Rdg +0.1°C)
Pt 1000 IEC	–200 to 850°C	–200 to 850°C	0.01°C	±(0.007% of Rdg +0.1°C)
Cu 10	–70 to 150°C	–70 to 150°C	0.1°C	±(0.007% of Rdg +0.4°C)
Cu 100	–180 to 150°C	–180 to 150°C	0.1°C	±(0.007% of Rdg +0.05°C)
Ni 100	–60 to 180°C	–60 to 180°C	0.1°C	±(0.007% of Rdg +0.05°C)
Ni 120	0 to 150°C	0 to 150°C	0.1°C	±(0.007% of Rdg +0.05°C)
mV	±100mV	±100mV	1µV	±(0.003% of Rdg +2µV)
V IN	±30V	±30V	0.1mV	±(0.007% of Rdg +0.3mV)
V OUT	±24V	±24V	0.1mV	±(0.007% of Val +0.3mV)
mA	±50mA	±50mA	1µA	±(0.007% of Rdg +0.7µA)
Ω IN	0 to 500 Ω 0 to 5000 Ω	0 to 500 Ω 0 to 5000 Ω	1 mΩ 0.01 Ω	±(0.005% of Rdg +12 mΩ) ±(0.005% of Rdg +120 mΩ)
Ω OUT	0 to 500 Ω 0 to 5000 Ω	0 to 500 Ω 0 to 5000 Ω	1 mΩ 0.01 Ω	±(0.005% of Val +20 mΩ) ±(0.005% of Val +200 mΩ)

Note: Accuracies shown are based on test at 23°C ±1°C for 90 days.
For input accuracy add ±1 digit

STANDARDS LAB THERMOCOUPLE SIMULATOR

Standards Lab Thermocouple Simulator	Model 5135
Metrology lab accuracy level, ±0.02°C for type K	
DC voltage and current calibrations also	
Calibrates most thermocouple types	

If you've been unsatisfied with the level of accuracy in the thermocouple simulators you've seen before, you'll be pleased with the Hart Model 5135 made by Xitron. The 5135 gives you thermocouple, DC voltage and current calibrations with the level of performance you expect from standards lab equipment.

Due to its high accuracy, the 5135 calibrates virtually any thermocouple instrument including other calibrators. Resolution of the thermocouple simulations is 0.01°C. Accuracy when simulating the common K couple is ±0.02°C. No other instrumentation approaches this accuracy for a similar price. Use the 5135 as a high accuracy readout with a calibrated thermocouple for high temperature calibration of other sensors.

Optional isolated RS-232 or IEEE interfaces are available for automated calibration applications. Use your PC to select instrument functions, set output values or record data.

Use of an external cold junction provides accuracy of ±0.02°C in the simulation of type K thermocouples. If the internal, active cold junction compensation is selected, accuracy is still ±0.1°C—far better than most thermocouple simulators.

An automatically sequenced internal calibration can be performed at any time. This procedure doesn't require any external equipment or connections, making it possible for the 5135 to maintain its high level of accuracy without external standards. For longer-term periodic recertification, an automatically sequenced external calibration is internally programmed. An optional password prevents unauthorized access to this calibration.

The 5135 gives you exceptional service as a DC voltage and current transfer standard also. DC voltage output accuracy is ±10 ppm and DC current accuracy is ±30 ppm. A 4–20 mA receiver calibration is enhanced by a user equation and units capability. The output level is computed using an equation derived from a pair of user entered points. Computation accuracy is 0.1 ppm.

We think this is the most advanced, most accurate thermocouple simulator available. Designed for serious calibration facilities, the 5135 is worthy of a standards lab role.

Specifications — Model 5135

Battery Type: Sealed Lead Acid

Discharge Time: 8 hours minimum from full charge (output < 10% load)

Charge Time: 6 hours maximum to full charge (with unit off) (12 hours with unit on). May be continuously charged.

Adapter/Charger: 115 VAC, 50/60 Hz

Indicators: Red LED when charging, green LED indicates sufficient operating power.

Output Terminals: Low thermal EMF binding posts. When using active C.J.C., output is via rear panel TC connector. TC measurements use rear panel TC connector.

Size: 6.3" H x 4.1" W x 9.7" D (160 mm x 104 mm x 246 mm)

Weight: 5 lbs (2.3 kg)

Operating Range: 0°C to 50°C, less than 70% RH

Isolation: Output to chassis, ground or interface: 1500V pk max

Ordering Information:

5135 Thermocouple Simulator	**$3,195**
5308-001 RS-232 Interface	**350**
5308-002 IEEE Interface	**445**
5308-003 Canvas Case	**130**
9301 Carrying Case	**155**

In the thermocouple simulation mode, the Model 5135 computes the required output voltage from NIST look-up tables for each respective thermocouple type using the user selected hot and cold junction temperatures. The resolution, accuracy and noise figures in Table 1 are mid-range figures relative to the NIST tables. The figures are based on using an external cold junction like the Hart Model 9101 Zero Point Dry-Well. When using the active on-board Cold Junction Compensation, 0.1°C should be added to the 90-day accuracy figures, and 0.01°C added to the noise figures shown in Table 1.

Thermocouple Simulation and Measurement Specifications

Type	Simulation			Measurement			Range
	Resolution	90 Day Accuracy	Pk–Pk Noise 0.01–10 Hz	Resolution	90 Day Accuracy	Pk–Pk Noise 0.01–10 Hz	
B	0.01°C 0.01°C	0.07°C 0.05°C	0.02°C 0.01°C	0.15°C 0.08°C	0.22°C 0.12°C + 0.01%	0.15°C 0.08°C	+200 to +300°C +300 to +1820°C
E	0.01°C 0.01°C	0.07°C 0.03°C 0.02°C	0.02°C 0.01°C 0.01°C	0.15°C 0.05°C 0.01°C	0.22°C + 0.01% 0.07°C + 0.01% 0.02°C + 0.01%	0.15°C 0.05°C 0.02°C	–270 to –260°C –260 to –70°C –70 to +1000°C
J	0.01°C 0.01°C	0.05°C 0.02°C	0.01°C 0.01°C	0.02°C 0.01°C	0.04°C + 0.01% 0.02°C + 0.01%	0.04°C 0.02°C	–210 to –140°C –140 to +760°C
K	0.01°C	0.02°C	0.01°C	0.01°C	0.02°C + 0.01%	0.02°C	–140 to +1372°C
N	0.01°C	0.02°C	0.01°C	0.03°C	0.07°C + 0.01%	0.07°C	–200 to +1300°C
R/S	0.01°C 0.01°C	0.06°C 0.04°C	0.01°C 0.01°C	0.06°C 0.03°C	0.11°C + 0.01% 0.06°C + 0.01%	0.11°C 0.06°C	0 to +200°C +200 to +1768°C
T	0.01°C 0.01°C	0.03°C 0.02°C	0.01°C 0.01°C	0.02°C 0.01°C	0.04°C + 0.01% 0.02°C + 0.01%	0.04°C 0.02°C	–200 to +100°C +100 to +400°C

Table 1

The accuracy figures given in Table 2 below are relative to Xitron Technologies Calibration Standards, and are valid throughout the temperature range of 18 to 28°C. Outside of this range, the relevant temperature coefficient adder should be applied.

For absolute accuracies, as shipped from Hart Scientific, add 3 ppm + 1 µV (DC Voltage) or 15 ppm + 20 pA (DC current) to the accuracy figures in Table 2. The 24-hour stability figures are valid for constant load and temperature (within 1°C) and are measured using a DC to 2 Hz bandwidth. All specifications are valid following a 2 minute period after setting the front panel POWER switch to the ON position.

DC Voltage and Current Specifications

Output Level	Resolution	24 Hour Stability	90 Day Accuracy	1 Year Accuracy	Temperature Coefficient	Pk – Pk Noise 0.01–10 Hz
DC Voltage						
<22 mV	10 nV	3 ppm + 80 nV	20 ppm + 0.2µV	30 ppm + 0.2µV	2.5 ppm + 30 nV	0.3 ppm + 40 nV
22–220 mV	100 nV	2.5 ppm + 0.1µV	15 ppm + 0.25µV	25 ppm + 0.25µV	2 ppm + 40 nV	0.3 ppm + 60 nV
0.22–2.2V	1µV	1.8 ppm + 0.5µV	12 ppm + 1µV	20 ppm + 1µV	1.5 ppm + 200 nV	0.3 ppm + 300 nV
2.2–22V	10µV	1.8 ppm + 3µV	10 ppm + 4µV	18 ppm + 4µV	1.5 ppm + 1µV	0.3 ppm + 2µV
DC Current						
<22µA	10 pA	7 ppm + 30 pA	50 ppm + 50 pA	70 ppm + 100 pA	5 ppm + 15 pA	1.5 ppm + 20 pA
22–220µA	100 pA	5 ppm + 150 pA	40 ppm + 150 pA	60 ppm + 250 pA	5 ppm + 100 pA	1.2 ppm + 100 pA
0.22–2.2 mA	1 nA	5 ppm + 1 nA	30 ppm + 1 nA	50 ppm + 2 nA	5 ppm + 1 nA	0.8 ppm + 500 pA
2.2–22 mA	10 nA	5 ppm + 15 nA	40 ppm + 20 nA	60 ppm + 30 nA	5 ppm + 10 nA	0.8 ppm + 5 nA
Settling Time: Less than 2 seconds to within 10 ppm of change + 250 nV/50 pA						
Drive Capabilities:	DC Voltage: 15 mA max (50 ohm Z_0 below 220 mV, 0.1 ohm max. above 0.22V)					
	DC Current: Greater than 18 V compliance ability					
Overload: Output is protected against short and open circuits, and applied voltages of up to 50V						

Table 2

PREMA MULTIMETERS

For the best precision in a Digital Multimeter we suggest a Prema DMM. Prema is internationally recognized for quality and performance in the metrology world.

For improved linearity and long-term stability Prema uses a patented multiple ramp technique for analog to digital conversions. It eliminates any noise introduced by user-selectable measurement time gaps with its continuous integration principle. The result guarantees a stable display and long-term measurement stability.

Select voltage, resistance, current, or even temperature as your measuring unit and configure the range and resolution to fit your application. Precise resistance measurements can be made for RTD and thermistor calibration work.

With built-in IEEE-488 interface, you can save time by automating your work. Add on an optional scanner to any model except the 5709 and add up to 20 inputs to increase throughput. Compare the specs and give us a call. If you require more detailed specifications, call us and we'll send them to you.

Ordering Information:

5712 DMM, 6½ Digit	**$995**
5703 DMM, 6½ Digit	**1,495**
5705 DMM, 6½ Digit	**1,695**
5708 DMM, 7½ Digit	**4,700**
5709 DMM, 8½ Digit	**5,900**
5711 DMM, 7½ Digit	**3,600**

Hart Ordering No.	5712	5703	5705	5708	5709	5711
Prema Model No.	4001	5001	6001	6047	6048	8017
Display Scale Length Range Selection Integration Times	6½ 1999999 manual, automatic 50ms to 10ms	6½ 1999999 manual, automatic 6 steps 50ms to 10s	6½ 1999999 manual, automatic 6 steps 50ms to 10s	7½ 19999999 manual, automatic 20ms - 80s/50Hz 16⅔ms - 80s/60Hz	8½ 199999999 manual, automatic 20 ms - 80s/50Hz 16⅔ms - 80s/60Hz	7½ 1999999 manual, automatic 1ms to 100s
DC Voltage CMRR/NMRR Ranges/Resolution Stability 24h Basic accuracy 1 year	true integrating 140dB/60dB 0.2V - 1000V/100nV 0.003% +0.0005% 0.01% +0.0002%	true integrating 140dB/60dB 0.2V - 1000V/100nV 0.0004% + 0.0002% 0.002% + 0.0002%	true integrating 140dB/60dB 0.2V - 1000V/100nV 0.0004% + 0.0002% 0.002% + 0.0002%	true integrating 160dB/100dB, PLL 0.2V - 1000V/10nV 0.0001% + 0.00005% 0.0007% + 0.0001%	true integrating 160dB/100dB, PLL 0.2V - 1000V/10nV 0.00005% + 0.00005% 0.0005% + 0.0001%	integrating,,sampling 160dB/100dB, PLL 0.3V-1000V/10nV 0.0004% + 0.0002% 0.002% + 0.0002%
Resistance Ranges/Resolution Basic accuracy 1 year	2-/4-wire selectable 200Ω–16MΩ/1mΩ 0.015% + 0.002%	2-wire 200Ω–16MΩ/1mΩ 0.002% + 0.0007%	2-/4-wire selectable 200Ω–16MΩ/100μΩ 0.002% + 0.0004%	2-/4-wire selectable 200Ω–20MΩ/10μΩ 0.0009% + 0.0001%	2-/4-wire selectable 200Ω–200MΩ/10μΩ 0.0007% + 0.0001%	2-/4-wire selectable 300Ω–300MΩ/10MΩ 0.002% + 0.0004%
AC Voltage Ranges/Resolution Basic accuracy 1 year	TRMS 0.2V–700V/1μV 0.3% + 0.07% (1kHz)	TRMS 0.2V–700V/1μV 0.08% + 0.03% (1kHz)	TRMS 0.2V–700V/1μV 0.08% + 0.03% (1kHz)	TRMS 0.2V–700V/100nV 0.02% +0.007% (1kHz)	TRMS 0.2V–700V/100nV 0.02% +0.007% (1kHz)	TRMS 0.2V–700V/100nV 0.05% +0.015% (1kHz)
DC current Ranges/Resolution Basic accuracy 1 year	2mA/10nA & 2A/10μA 0.004% + 0.004%	2mA/1nA & 2A/1μA 0.007% + 0.002%	2mA/1nA & 2A/1μA 0.007% + 0.002%	2A/1μA 0.003 + 0.001%	2A/1μA 0.003% + 0.001%	300A–2A/100pA 0.01% + 0.001%
AC current Ranges/Resolution Basic accuracy 1 year	TRMS 2mA/10 & 2A/10μA 0.5% + 0.07% (1kHz)	TRMS 2mA/10nA & 2A/10μA 0.04% + 0.04% (1kHz)	TRMS 2mA/10nA & 2A/10μA 0.04% + 0.04% (1kHz)	TRMS 2A/1μA 0.04% + 0.04% (1kHz)	TRMS 2A/1μA 0.04% + 0.04% (1kHz)	TRMS 200μA–2A/100pA 0.04% + 0.02% (1kHz)
Temperature Ranges/Resolution Tolerance	4-wire RTD (Pt100) –200C–850°C/0.01°C 0.05°C		4-wire-RTD (Pt100) –200C–850°C/0.01°C 0.05°C	4-wire-RTD (Pt100) –200°C–850°C/0.01°C 0.05°C	4-wire-RTD (Pt100) –200C–850°C/0.01°C 0.05°C	4-wire-RTD & T/C –270C–1820°C/0.01°C 0.004% + 0.02°C
IEEE 488 Interface Supported functions Input information Output information	SH1, AH1, T5, L3, RL1, DC1, DT1, SR1 function, range, integration time, trigger, calibration data result, function, range, integration time, operation mode					
Scanner	10 channels (Opt)	10 channels, 4-pole (Opt)	10 channels, 4-pole (Opt)	20 channels, 4-pole (Opt)	NA	80 - 1 pole, 40 - 2 pole(Opt)
Special features	Mathematics program set 15 ppm stability low cost	1G input resistance up to 2V, Analog display, memory 6 Mathematics programs	1G input resistance up to 2V, Analog display, memory 6 Mathematics programs	Sockets with very low emf. Math. programs set, Automatic scan control, 10G up to 20V	Sockets with very low emf., 2 currents in measurement, Drift compensation, 10G up to 20V	Multi-Display Technique Graphical LCD Display of up to 3 measurement values
Price	**$995**	**$1,495**	**$1,695**	**$4,700**	**$5,900**	**$3,600**
With Built-in Scanner	5712-001 **$1,595**	5703-001 **$2,095**	5705-001 **$2,295**	5708-001 **$5,900**	NA	5711-001 **$4,800**

7½ DIGIT DIGITAL MULTIMETER — Model 5711

7½ Digit Digital Multimeter	Model 5711
Large LCD graphic information display	
Precision thermistor and PRT resistance measurements	
Read thermocouples and Pt100s directly in °C or °F	
Optional 80-channel scanner (40 2-pole)	

The Hart Model 5711 is another great multifunction meter from Prema Precision Electronics. It has 7½ digits of resolution, a large LCD display and multiprocessor technology for the best multimeter performance currently available.

Measure voltage, current, resistance, temperature or frequency and see the data in text, graphical or oscilloscope modes along with simultaneous display of a variety of statistical functions. You can measure AC Voltage and see the RMS value, Peak Value and Crest Factor all on the screen at the same time.

The 5711 processes up to three signals at the same time. It stores up to 40 files of 15,000 records each and has an RS-232, IEEE and Centronics interface for connecting to your PC. Automate your calibration system and get the most from this instrument.

For precision PRT and thermistor measurements you can read resistance at maximum accuracy. If you're reading industrial temperature sensors use the internal temperature conversions to read thermocouples and RTDs directly in °C and °F.

Use the 5711 alone or add the optional 80-Channel Scanner for multiple input measurements. High precision measurements with 7½ digits of resolutions have a 24-hour stability of 4 ppm. High speed measurements as fast as 1000 per second are possible with 4½ digits of resolution in the oscilloscope mode.

State-of-the-art measurement is provided by Prema's Multiple-Ramp Method 25 Bit A/D converter, an exclusive Prema design technology. With more than 20 years of multimeter design you know you're getting the best in technology.

For more complete information on this or other Prema products call Hart at 1-800-438-4278.

Specifications

Measurement Functions: VDC, VAC, IDC, IAC, Ω, °C/°F/Kelvin, Hz

Resolution: 100nV, 1nA, 100μΩ

Accuracy:

VDC (30V)
24-hour: ±0.0004% + 0.0002
1-year: ±0.002% + 0.0002

Resistance (30Ω):
24-hour: ±0.0004% + 0.0002
1-year: ±0.0009% + 0.0004

RTDs (Pt100)
24-hour: ±0.002% + 0.03°C
1-year: ±0.004% + 0.02°C

Thermocouple (Type K)
1-year: ±0.16°C (with measurement times > 400ms)

Interface: IEEE-488, RS-232 with SCPI, TTL-I/O and Centronics

Inputs: Single input on main unit, 80-channel scanner optional

Ordering Information:

5711 DMM	**$3,600**
5711-001 DMM with 80-channel scanner (40 2-pole)	**4,800**

6 ½ DIGIT DIGITAL MULTIMETER — Model 5712

6½ Digit Digital Multimeter	Model 5712
6½ digit resolution	
Low cost	
Temperature measurement with RTDs (Pt100)	

If you're looking for an excellent high quality DMM and six and one-half digit resolution fits your needs, the Hart Model 5712 is a great calibration DMM.

It has a stability of 15ppm (24-hours) and accuracy of 35ppm (1-year), six selectable integration times (50 ms, 100 ms, 500 ms, 1 s, 5 s and 10 s), a complete set of algorithms for Offset, Deviation %, Increment, Ratio, dB, and dBm, along with a standard IEEE-488 interface.

The 5712 can measure temperature directly with Pt 100 sensors and it is capable of 2-wire or 4-wire measurements. You can store 100 readings in the internal measurement memory and read them back through the keyboard or the IEEE-488 port. The number of measurements to be stored is programmable through the front panel.

Lead resistance offset corrections and other calibration adjustments can be made for each function and range of the instrument. Load this data in the battery RAM and forget about having to input it again each time. The original factory calibration data is stored in the EPROM for retrieval and loading when desired for a return to the original specifications.

A self-test routine checks the DMMs analog and digital sections each time the instrument is turned on, thus ensuring the correct and accurate operation of the multimeter.

The temperature range is –200°C to 850°C, and the DMM has an optional built-in ten channel scanner for automated collection of data. A switch on the back panel prevents the accidental erasing of the calibration data in RAM.

This is an outstanding benchtop instrument. It's a high quality and reasonably priced multimeter for the serious calibrationist.

Specifications

Stability: 24 hours 0.003%

Resolution: 100 nV, 1 nA, 100 μΩ, 0.01°C

Input Resistance: 10 GΩ

Display Resolution: 1999999

Ordering Information:

5712 DMM	**$995**
5712-001 DMM w/10 Channel Scanner	**1,595**
5301-001 Scanner Terminal Adapter	**120**
5301-009 Pt100 Temp Sensor	**215**

THERMO-HYGROMETER — Model 5100

Here's an easy and low-cost way to get humidity and temperature data for your calibration records. Use this meter everywhere you need to check lab or plant environments.

This new, attractive indicator is ideal for desktop or wall mounting applications. Large bright LCD shows temperature in both °C or °F, along with relative humidity, and min/max readings for both functions.

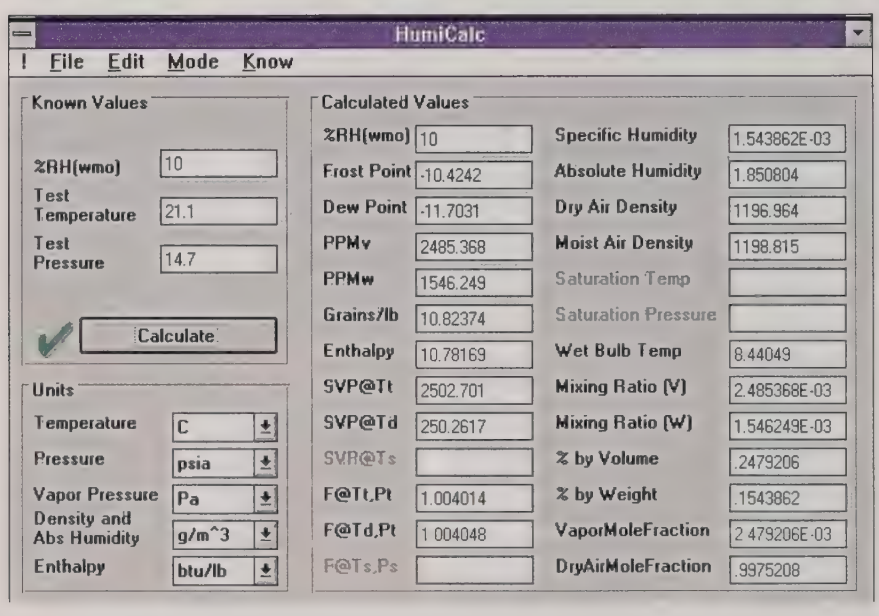
Measuring ranges include 32°F to 122°F (0°C to 50°C) for temperature with accuracy of ±2°F (±1°C) and 25 to 96% RH with accuracy to ±5% in the 40 to 80% RH range, ±7% otherwise.

Memory function stores minimum and maximum measurements for both temperature and humidity. Complete with built-in tilt stand, wall mounting bracket and two AAA batteries.

Ordering Information:

5100 Thermo-Hygrometer **$49**

HUMICALC® SOFTWARE — Model 9921



If you're working with humidity measurements you're doing complex calculations for conversions often. If you've been doing the work with a pencil and a calculator, or using a spreadsheet, now there's a better way.

The Hart's Model 9921 HumiCalc® software automatically does complex humidity conversions for you. Just fill in the values screen and push the calculate button. The rest is automated. No more tables! No more guess work! You get the right answer every time.

The typical calculation requires only a temperature, a pressure, and one known humidity parameter. HumiCalc then computes all other humidity values including:

- %RH
- Specific Humidity
- Absolute Humidity
- Frost Point
- Dew Point
- PPMw
- PPMv
- Moist Air Density
- Dry Air Density
- Vapor Pressures
- Grains per pound
- Enthalpy
- Mole Fraction of Dry Air
- Wet Bulb Temperature
- Enhancement Factors
- Mixing Ratio by Volume
- Mixing Ration by Weight
- Percent by Volume
- Percent by Weight

With the multiple calculation feature, you can automatically convert an entire range of data, selectable end points and step sizes. Import HumiCalc data into your favorite spread sheet or graphing program.

You can't beat the price, the product, or the features. This is another great product from Hart and Thunder Scientific.

Calculation Range

Relative Humidity ≈0.001 to 100.00 %RH
Frost Point: –99.99°C to 0.01°C
Dew Point: –99.99°C to 100.0°C
Temperature: –99.99°C to 200.0°C
Pressures: Near 0 to 5000 psia

Ordering Information:

9921 HumiCalc® Software **$99**

LAB HUMIDITY/TEMP RECORDER — Model 5109

Lab Humidity/Temp Recorder	Model 5109
Document lab conditions for quality audits	
Note current RH and temp on your cal certificates	
Recalibrate the detachable probe in Hart's 5110 RH calibrator	
Locking control keypad prevents tampering	

In our calibration lab, we record the ambient humidity and temperature on a circular chart recorder. To do this job, we've searched for a long time to find the right instrument, and now we've got it and you can get it too.

The Hart Model 5109 humidity recorder is a microprocessor based instrument with a battery backup system that won't fail you. It records temperature and humidity or temperature and dew point. It has a digital display so you can easily read the current temperature and humidity at once without trying to read the circular chart directly.

The front panel keypad allows direct user input of high/low alarm values, temperature readout in degrees C or F, range and recording times, including 1, 7 and 31 day times. Recalibration of the new sensor can be done in a small humidity calibrator like Hart's Model 5110 on page 140. This saves time and money.

Each recorder comes complete with batteries, two pens, AC adapter and a starter box of charts containing ranges: –20 to 120°F and –20 to 50°C in one day and seven day recording times. Buy the ten-foot extension cable for calibration of the sensor or for location of the sensor away from the recorder. Cables up to 100 feet long are available. This unit has an accuracy of ±1.0°C and ±2% humidity accuracy between 10 and 90% humidity. It's small, only 10 by 13 inches, and it features the latest in recorder technology.

It works great in our lab, and it will work great in yours.

Specifications

Temperature Ranges: User selectable: 20 to 120°F, 40 to 110°F and 20 to 50°C, 4 to 40°C

Temperature Accuracy: ±1.8°F (±1.0°C)

Humidity Range: 0–99%

Humidity Accuracy: ±2% between 10 and 90% (at 73°F, 23°C)

Display Resolution: 1°F (1°C), 1% RH

Chart Size: 8" diameter (203 mm)

Temperature Sensor: Thermistor

Humidity Sensor: Thin film capacitor

Recording Time: User selectable, 1-, 7-, and 31-day

Power: 120 V AC adapter with 4 D batteries for backup power

Body Dimensions: 10.5" x 13.2" x 2.8" (267 mm x 335 mm x 71 mm)

Probe Dimensions: .92" dia x 5.9" long (23.4 mm x 150 mm)

Weight: Approximately 7 lbs (3.2 kg)

Mounting: Portable or wall mountable

Calibration: User calibration of all variables

Alarms: Audio/visual high and low alarms

Response Time: Temperature: 30 seconds for a 63% step change at 1 cfm, RH: 20 seconds for a 63% step change at 1 cfm

Operating Range (Body): 10% RH to 90% RH, 32°F to 122°F (0°C to 50°C)

Ordering Information:

5109 RH/Temp Recorder	**$650**
5311-001 10 ft Probe Cable	**35**
5311-002 Pens	**35**
5311-003 Assorted Charts	**25**

(Call for a complete list of available charts)

RELATIVE HUMIDITY CALIBRATOR — Range: 0–99.9% RH

Relative Humidity Calibrator	Model 5110
An affordable RH calibrator	
Wide range, 0 to 99.9% RH	
Maintains accuracies of 1.0% between 20% and 80% RH	
Completely portable with carrying case	

The Model 5110 calibrates or verifies any RH from 0.0% to 99.9% in increments of 0.1% RH. It's an affordable, portable system for RH calibrations.

Each calibrator comes complete with its own NIST traceable certificate of calibration. Greater accuracy and convenience are achieved by using the calibrator with a NIST traceable hygrometer, providing an easy-to-use calibration transfer standards system for laboratory or industrial use.

The 0–99.9% RH range allows testing and calibration of humidity instruments at the %RH where they will be used. Your test values are not limited to the fixed points provided by salt bottles. Any setpoint you select is stable and repeatable to 0.2% RH, giving your calibrations a high degree of integrity both during your tests and from one use to the next. Uncertainty does not increase rapidly over time as it does with salt bottles.

A divided air flow system is used to generate the RH level quickly and accurately in the built-in test chamber. A column of air is separated into two precisely proportioned streams, one saturated and the other dry. The desired %RH is created by precision mixing of the air streams.

Relative humidity can be set on the LED display in 0.1% increments by using the increment/decrement switch to scroll through setpoints.

It has an RS-232 port so test profiles can be automatically loaded into memory from your PC. The menu driven software allows the user to create a customized %RH vs. time plot with ramping or step changes.

The covered test chamber is easily accessed through a lift-off acrylic lid that can be drilled and modified to your needs.

Use the 5110 in your lab or carry it to your installed sensors. No other RH calibrator matches the Model 5110's low cost and versatility. For accurate RH measurement now — give Hart a call.

Specifications — Model 5110

Generation Method: Divided flow

Operating Range: 0.0 to 99.9% RH.

Repeatability: 0.2% RH

Accuracy:

0–10%	±4.0%RH
10–20%	±2.0%RH
20–80%	±1.0%RH
80–90%	±2.0%RH
90–99.9%	±4.0%RH

Response Time: Less than 5 minutes

Stability: 0.2%RH

Test Well Size: 3.2" x 5.8" x 3.7" D (81 mm x 147 mm x 94 mm)

Storage: Full: 1°C to 38°C
Drained: –54°C to 49°C

Power: 120 VAC

Integral Power Supply: 24 VDC

Weight: 12 lbs (5.4 kg)

Size: 12" H x 16" W x 10" D (305 mm x 406 mm x 254 mm)

Ordering Information:

5110 Humidity Generator **$2,549**

AIR RESISTORS

Air Resistors

- Convenient Air Resistors don't require oil or air baths
- Calibrate resistance thermometers and other devices
- Includes NIST traceable calibration data accurate to 1 ppm
- Easily transported for on-site resistance calibration

Have you been thinking about getting some standards resistors? Have you thought about air resistors and their advantages?

Customers tell us they want a quick and affordable method for calibrating resistance thermometers. They don't want to use the traditional standards resistors because of the problems and expense of maintaining the resistors in an oil bath.

To solve the problem, Hart is offering air resistors with a calibration accuracy of one ppm, depending on the resistance. And calibration data supplied with each resistor provides corrections in 0.5°C increments so you can reduce uncertainty even more.

Nine standard values are available from 1 ohm to 10 Megohms, and custom values are available for an additional cost. Optional transit cases hold two resistors at a time so you can take them with you to use where you need them. These resistors are temperature stable, and they resist thermal and mechanical shock. Each unit has four 5-way binding posts for 4-terminal measurement. The binding posts are constructed of tellurium copper for low thermal EMF and low resistance. A case ground terminal is provided.

This is cost effective precision.

Model	Mfr's Model	Nominal Value (Ω)	Adjustment to Nominal Value (ppm)	Stability 12 Months (ppm)	Calibration Accuracy (ppm)	Resistance Change (ppm) (18°C - 28°C)	Max. Power Rating (milliwatts)
5401	SRL-1	1	±2	8	1.0	3	250
5402	SRL-10	10	±2	8	1.5	5	100
5409	SRL-25	25	±2	8	1.5	5	100
5403	SRL-100	100	±2	8	1.5	5	100
5404	SRL-1k	1 k	±2	5	1.0	1.5	100
5405	SRL-10k	10 k	±2	4	1.0	1.5	100
5406	SRL-100k	100 k	±3	6	2.5	1.5	100
5407	SRL-1M	1 M	±4	8	5.0	3	10
5408	SRL-10M	10 M	±5	9	10.0	5	10

Specifications

Accuracy and Stability: See table below

Temperature Range: 18°C to 28°C

Retrace: Permanent shift in resistance value is <2 ppm for 23°C to 0°C to 23°C cycle, and 23°C to 40°C to 23°C cycle

Calibration Report: Initial calibration data provided in 0.5°C increments for temperature range of 18°C to 28°C.

Calibration Conditions: 4-wire Kelvin measurements with shield, low power, at 23°C

Terminals: Four 5-way binding posts for 4-terminal measurement. The binding posts are constructed of tellurium copper for low thermal EMF and low resistance. A case ground terminal is also provided.

Storage Temperature: 0°C to 40°C

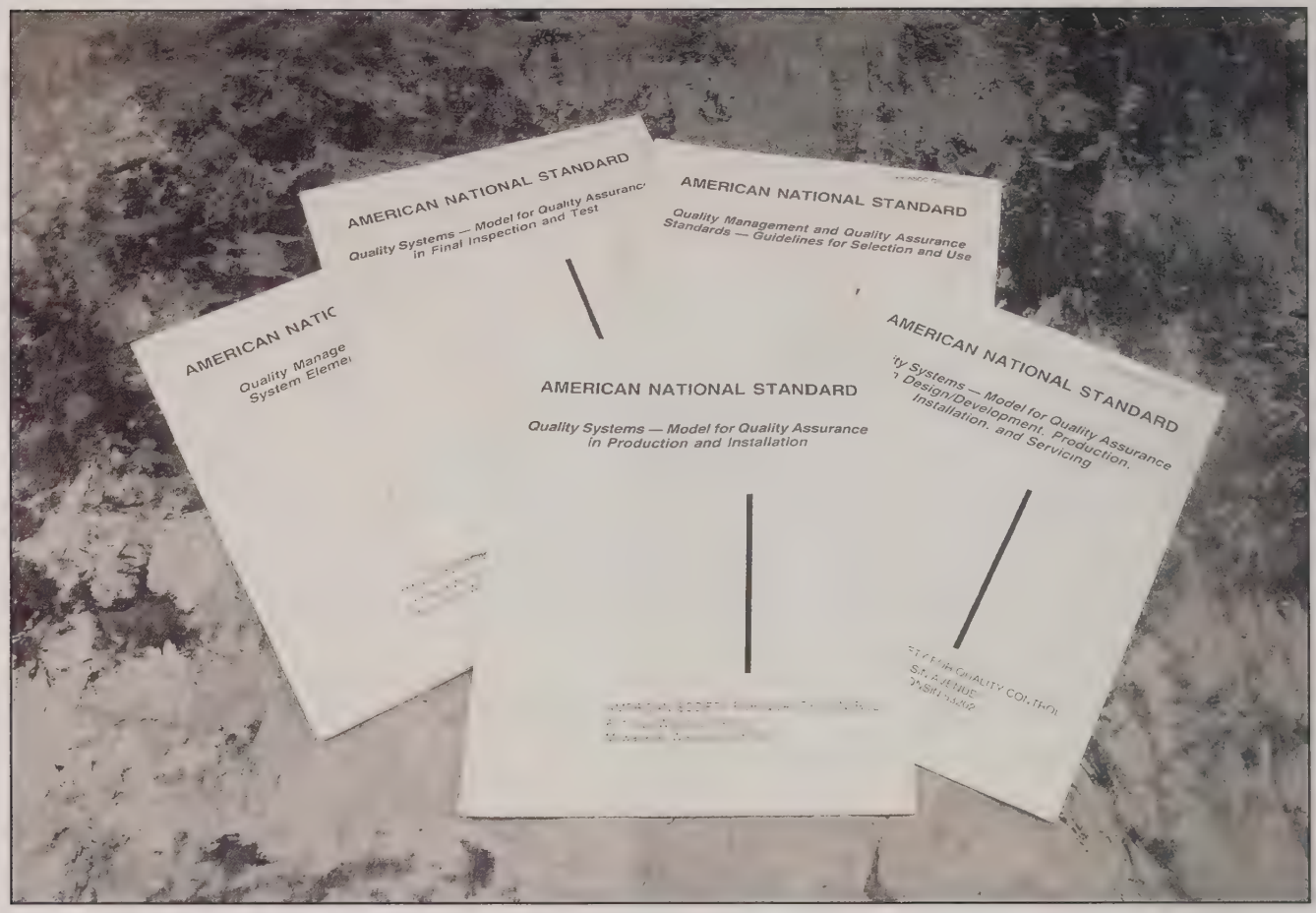
Dimensions: 3.4" H x 4.15" W x 5" D (8.6 cm x 10.5 cm x 12.7 cm)

Transit Case: Optional Model 5421. The SRC-100 lightweight metal transit case with handle capable of storing two SR series units.

Ordering Information:

5401 SRL-1, 1 Ω	**$1,389**
5402 SRL-10, 10 Ω	**1,389**
5409 SRL-25, 25Ω	**1,389**
5403 SRL-100, 100 Ω	**1,389**
5404 SRL-1k, 1 kΩ	**1,389**
5405 SRL-10k, 10 kΩ	**1,389**
5406 SRL-100k, 100 kΩ	**1,389**
5407 SRL-1M, 1 MΩ	**1,389**
5408 SRL-10M, 10 MΩ	**1,389**
5421 SRC-100, Transit Case	**350**

ISO 9000 STANDARDS


AMERICAN NATIONAL STANDARD
Quality Systems — Model for Quality Assurance in Final Inspection and Test
AMERICAN NATIONAL STANDARD
Quality Management and Quality Assurance Standards — Guidelines for Selection and Use
AMERICAN NATIONAL STANDARD
Quality Systems — Model for Quality Assurance in Production and Installation
AMERICAN NATIONAL STANDARD
Quality Systems — Model for Quality Assurance in Design/Development, Production, Installation, and Servicing

These standards are designed to ensure consistent quality requirements between manufacturers around the world. While we know many of our customers are thinking about ISO 9000, or have started the process, some customers are having difficulty getting adequate information about ISO 9000.

As a customer service, Hart is offering a five-volume set of ANSI/ASQC Q90–94 Guidelines for ISO 9000–9004. These standards were prepared by the Technical Committee ISO/TC 176 on Quality Assurance in the interest of harmonizing the large number of international standards in the QC field.

This series is published by the American Society for Quality Control with customary American language and spellings making them easy to understand and interpret. The five volumes come as a set and include:

ANSI/ASQC Q90 (ISO 9000)
Quality Management and Quality Assurance Standards — Guidelines for Selection and Use

ANSI/ASQC Q91 (ISO 9001)
Quality Systems — Model for Quality Assurance in Design/Development, Production, Installation, and Servicing

ANSI/ASQC Q92 (ISO 9002)
Quality Systems — Model For Quality Assurance in Production and Installation

ANSI/ASQC Q93 (ISO 9003)
Quality Systems — Model for Quality Assurance in Final Inspection and Test

ANSI/ASQC Q94 (ISO 9004)
Quality Management and Quality System Elements — Guidelines

Ordering Information:

9397 Q90 Set (ISO 9000)	**$85**

CAL-PRO 9000 ASSET MANAGEMENT SOFTWARE — Model 9922

Cal-Pro 9000 Asset Management Software	Model 9922
Complete records for all instruments in your plant	
Detailed asset cost tracking	
Calibration recall and status reports	
50 standard reports	

Have you been thinking about buying some asset management software but have held off because of the price? Hart's new asset management software gives you all the features you need for a price that is simply unbelievable.

Organize and track company assets for compliance with quality programs, audits and ISO 9000 with this flexible complete Windows™ program. It's comprehensive with more than 50 standard reports for your convenience, or create your own using ACCESS or CRYSTAL REPORTS. Each program function lets you select any of three levels of protection to prevent unauthorized or accidental change of asset information.

You just can't manage lab audits effectively without asset management software, and no one else gives it to you at this price. Check out the list of features below. And it works in several languages including English, French, Spanish, German and Italian.

We like this software so much we use it in our own lab. At this price what have you got to lose!

Features

- Easy to use Windows™ interface
- On-screen help
- Language selection: English, French, Spanish, German, Italian
- Track warranties and service contracts for all instruments
- Asset location tracking
- Calibration recall and scheduling
- Complete calibration history record
- Repair history tracking
- Asset costs including:
  - Original purchase
  - Repairs
  - Recalibration
  - Depreciation
  - Total cost of ownership
- 50 standard reports including:
  - Approved cal labs
  - Approved repair labs
  - Warranty sources
  - Assets by calibration intervals
  - Assets by manufacturer
  - Assets by serial, model or asset number
- Custom reports using Access™ or Crystal Reports™

Ordering Information:

9922 Cal-Pro 9000	**$500**

INSTRUMENT CASES

Premium Line

Transporting your portable calibration instruments anywhere from Antarctica to the Amazon is now easy with Hart's nearly-indestructible line of instrument cases.

In our premium line, Models 9303, 9302 and 9301 are virtually unbreakable. They're backed by our lifetime guarantee, which covers practically everything except shark bite, bear attack or use by children under five. Trash 'em, smash 'em or throw 'em out on an L.A. freeway—they can take it.

These cases are made of lightweight, spaceage ABS structural foam resin that won't dent, crack or corrode. Their O-ring seal makes these cases so airtight and watertight, they float even when fully loaded. You can forget about corrosion or contamination from salt water or airborne chemicals. Each case has a pressure purge valve to compensate for changes in temperature and altitude.

The positive-locking molded latches won't break or open accidentally in use. Prescored foam inserts make the cases adapt to any instrument quickly and easily.

Standard Line

For our customers who aren't planning a calibration expedition to Antarctica but still want a good quality instrument case, Hart offers its standard line, Models 9305, 9306 and 2601.

These cases are blow molded from high density polyethylene for resistance to gasoline, oil and most chemicals. Like our premium line, these cases will not rust or corrode, and they don't dent or chip like wood and metal. They're lightweight, easy to carry and unaffected by ambient temperature extremes. They come with our standard one-year warranty.

Hart has a case for all your portable instruments. Expensive, sensitive calibration tools need protection.

Compare the cost of these cases to the cost of your instruments, and you'll agree the price of a case is a small price to pay for instrument security.

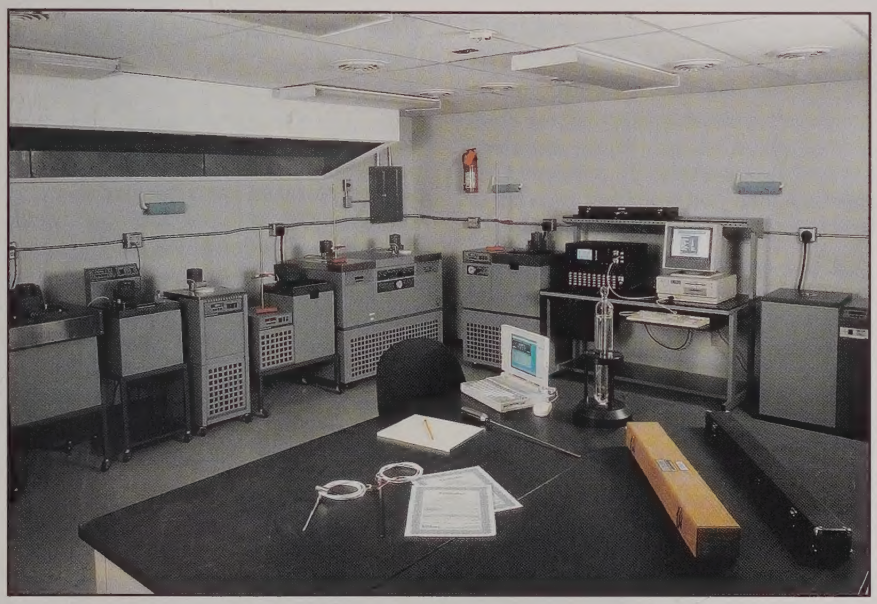
The correct case for each instrument in this catalog is specified in the "Ordering Information" sections included throughout the catalog.

Ordering Information:

9303	Standards Probe Case 34" L x 13" W x 5" D	**250**
9302	Large Instrument Case 22" L x 17" W x 8" D	**235**
9301	Medium Carrying Case 18" L x 12" W x 6.5" D	**155**
9305	Small Instrument Case 14" L x 11" W x 3.5" D	**$50**
9306	Medium Length Probe Case 24" L x 13" W x 3.75" D	**80**
2601	Probe Case 15" L x 6.5" W x 2" D	**45**

Dimensions on all cases are inside measurements.

HART CALIBRATION SERVICES



All of the instruments and sensors manufactured by Hart have been calibrated by Hart's own calibration technicians before we ship them to you.

When it's time for scheduled recertification of your instruments, why not have Hart check your calibration equipment, and if necessary, fine tune it back to its original level of performance? Hart will recalibrate all of the equipment offered in this catalog plus working temperature sensors from any manufacturer.

For precision calibrations, Hart uses its own high stability baths for temperatures from –100°C to 500°C. For calibrations up to 1,100°C, comparison calibrations are made using furnaces or special block calibrators. All comparisons are made against NIST calibrated or NIST traceable standards thermometers, depending on the level of uncertainty tolerable. Standards resistors and thermocouple simulators are used to calibrate readout or control instruments.

Comparison calibrations of Standards Platinum Resistance Thermometers are performed in Hart baths against a NIST calibrated SPRT, giving you the lowest uncertainty attainable in a commercial lab.

If you don't have your own primary standards lab, and the long lead time on NIST calibrations is a problem, why not give Hart a call? We give your instruments and sensors the best possible recertification and attention to detail, along with fast, reliable service. Fixed point calibrations up to the silver point are also available. See page 8 for SPRT calibration pricing.

Ordering Information:

Following are standard charges for recertification or recalibration of several of Hart's instruments. Please call Bryan Cowley or Steve Iman to order a calibration or to request a complete price list.

Thermometers	
1502 Tweener Thermometer	$ 95
1506 Metrology Thermometer	200
1575 Super-Thermometer	200
Dry-Wells and Furnaces	
9100 HDRC Dry-Well	220
9101 Zero Point Calibrator	100
9105 Low Temp Dry-Well	220
9120 200°C Dry-Well	190
9121 600°C Dry-well	190
9122 High Capacity Dry-Well	250
9123 High Speed Dry-Well	220
9125 Surface Calibrator	190
9130 IR Calibrator	220
9113 Portable Furnace	220
Humidity	
5110 RH Calibrator	500
Probes	
5610 Thermistor Probe	275
5611 Bare Thermistor Probe	275
5613 6" PRT	350
5614 12" PRT	350
5630 Type S Thermocouple	250
5637 Type S Thermocouple	250
5690 Smart Probe, 0.01°C	480
5691 Smart Probe, 0.03°C	425

NEVER-HAVING-TO-SAY-WE'RE-SORRY

Are We Nuts?

Every year we like to introduce a new customer service program that makes other companies wince. And this year we've got another one sure to concern those companies unwilling or unable to match Hart's service.

Most of you are familiar with our "Service-or-We-Pay" program where we give you $20 a day for every working day we're late with warranty service or repairs. This is a great program that no one else in the industry dares to match. Test them on this if you don't believe me. Ask them how they're going to compensate you when they're late and cost you time, money and frustration.

Twenty dollars a day may not seem like much, but it keeps the pressure on us to perform and that's the whole point—performance of both the equipment and the people.

So what's new this year? It's our "Never-Having-To-Say-We're-Sorry" program. Oh, it's not that we don't make mistakes because we do, and like everyone else we sometimes need to apologize. However, simply saying "I'm sorry" is not enough, so now if we can't meet the commitments we've made to you and we need to say we're sorry we're going to do more than just apologize.

How many times have you found yourself listening to someone give you an excuse for their poor performance, and finally, after you express your frustration they say "Well, I'm sorry!"

I've found myself in this situation many times, wishing that the person saying "I'm sorry" was at least sincere. It's not that I'm so unforgiving that I don't understand that mistakes happen. Of course they do. But when I'm on the short end of someone else's mistake I wish they could at least empathize with my situation and the problems their errors have caused.

So at Hart we're going to take apologizing a step further. Instead of just saying we're sorry, we're going to give you $20, $50 or $100 in discounts, gifts or cash in addition to our apology. If someone at Hart has to apologize for failing to perform as promised and forgets to offer you the "Never-Having-To-Say-We're-Sorry" compensation, just remind them and they'll increase the amount of our empathy by another $20.

Sure it's a small amount, but the point of all of this isn't simply to give you something, it's to train us to do a better job of preventing the problems that cause us to have to say we're sorry in the first place.

If the new "Never-Having-To-Say-We're-Sorry" program isn't enough, we're going to keep our "Service-or-We-Pay" program too.

Remember, *sorry is as sorry does!* Ask other companies you do business with what they're going to do for you when they make a mistake, or how they're going to compensate you if they're late with their service. Go ahead, ask them!

Have You Read Hart's Temperature Calibration Newsletter?

Our newsletter is called *Random News* and we're going to publish it whenever we feel like it. That's why it's called *Random News.*

It's got articles on temperature calibration, a column on industry myths, a metrology crossword puzzle, a few calibration jokes and some wit, wisdom and interesting facts about the business of calibration. If you haven't received your copy yet call 1-800-438-4278 (1-800-GET-HART) and we'll sign you up. The newsletter is free and so is the call.

If you don't want a copy of the newsletter but feel like a little country music and want to talk to Garth Brooks (or at least a recording of Garth Brooks) you can call 1-900-438-4278 (1-900-GET-GART). A call to Garth Brooks is definitely **NOT** free and won't get you a newsletter, but you might enjoy the call anyway.

How do we know about this? Well, we answer about 150 calls a month from people wanting to talk to Garth. They're very disappointed when they only get me, even though I've sung a few country songs to them just to perk up their day. So please, don't call us and ask for Garth thinking it might be funny. I might have to sing to you, too. By the way, do any of you know his home phone number? We've got something we'd like to talk to him about.

What Happened to the Apple on the Cover?

Last year there was an apple on the cover. And this year it's gone.

No one could remember exactly why we put an apple on the cover but we did, and it was a popular item. We received several orders for apples during the year.

To understand the apple situation last year we created a top ten list of reasons why we used an apple in the first place. Several people sent in suggestions for adding to the top ten list, and we appreciated every one of them. Well, most of them anyway.

The apple drew so much favorable response we had to create another top ten list to figure out why we didn't use it again this year.

The top ten reasons the apple isn't on the cover:

10. Red is out this year.
9. We gave it away on Halloween.
8. The accounting department couldn't figure out what account to charge it to.
7. This year it looked sort of brown and wrinkled.
6. We shipped it by mistake.
5. It was politically incorrect.
4. It fell off the fork lift truck while we were trying to store it.
3. An elephant stepped on it.
2. We fired the only person who knew where we put it.

And finally, the number 1 reason the apple isn't on the cover:

1. Wayne ate it.

Purchasing Information:

To order, call us toll-free at 1-800-438-4278 (in Utah call 801-785-1600). Although we require written confirmation and/or purchase orders before confirming delivery dates for orders over $1,000, upon receipt of your call or fax we'll schedule your equipment for production, which ensures the fastest delivery possible. Let us know what you need, and we'll get it on its way to you. Send or FAX confirmations to:

Hart Scientific, Inc.
P.O. Box 460
Pleasant Grove, Utah 84062
FAX: **1-801-785-7118**

Application Assistance:

Use our toll-free number and ask for the sales department. We will be glad to discuss your specific application and then provide recommendations or other assistance as you desire.

Prices:

All pricing in this catalog is for information and your convenience only. Effective date is May 1, 1995. All prices are subject to change without notice. Please confirm pricing before submitting a completed purchase order.

Shipping:

All published prices are F.O.B. Pleasant Grove, Utah. Many items in this catalog are too large for UPS shipping. Unless otherwise requested by the customer, we prefer to use a two or three day air express service. It costs the same (sometimes less) than regular surface shipment.

We'll use the carrier of your choice but you have to pay for insurance. If we pick the carrier you don't have to buy insurance. Now pay attention here, we mean it. We don't cover shipping damage if your purchasing department picks the carrier. NO EXCEPTIONS!

Delivery:

Items in this catalog have normal delivery times of one week to 90 days depending on the item. We, therefore, suggest that you call and discuss your equipment needs for one to three month intervals. Custom or modified products may take longer than 90 days.

Specifications:

Hart Scientific reserves the right to modify, change, or improve any or all specifications published in this catalog without notice. All products will conform to current specifications published or quoted at the time of order.

"Service-or-We-Pay" Policy:

If you send an item in for warranty, and Hart has it in our plant for more than 5 days from the time we receive it, we'll pay your company $20/day for each day beyond 5 that we keep it. This policy applies only to items manufactured by Hart Scientific. It also excludes fixed point cells.

For repair items, call in for a return authorization number, and we'll give you an estimate of how long it will take us to do a particular repair. We'll send your company $20/day for every day we take beyond our initial estimate.

The $20/day payment on repairs is limited to items that can be repaired, which can only be determined after we receive the instrument in our plant.

Late payments can be redeemed in cash, merchandise or discounts. Call for details. (Any item returned for repair or warranty must have a return authorization number given by our customer support group.)

Warranty:

Look for Hart's two-year, three-year and lifetime warranty symbols. Other instruments without a symbol carry Hart's industry leading one-year warranty. Warranty includes parts and labor but not shipping. Probe warranties are for 90 days unless a one-year symbol is shown.

Remember, all warranties come with an exclusion for damage by misuse, abuse or negligence. We shouldn't have to say this but misuse is the number one problem we see—especially with SPRTs. So be careful. And call us if you have any questions. Consequential damage is not covered by Hart's warranty under any circumstances. All warranties and programs apply only to products sold in the U.S.

Here's How You Can Plant-A-Tree!

A few years ago Hart Scientific became a helping partner in the American Forestry Association's Global Releaf program. We've planted thousands of trees through this program and we're pleased to continue this year.

This program is dedicated to planting 100 million new trees across the nation. To help Global Releaf, Hart Scientific and the American Forestry Association will plant one new tree for each order made from this catalog. With your shipment you will receive a certificate confirming your commitment and effort on behalf of the environment.

If you're interested in Global Releaf, give us a call and we'll send you more information on how you can participate in the program directly.

Hart Scientific, Inc.
220 North 1300 West
P.O. Box 460
Pleasant Grove, Utah 84062-0460

Address Correction Requested

In this year's catalog check out the new Model 9100 HDRC Handheld Dry-Well. It's a great new product for checking thermometers, and it's so inexpensive you can buy several. On page 146 find out why there's no apple on this year's cover, and on page 107 see how our chairman is spending his time. We've got our new "Never-Having-to-Say-We're-Sorry" program along with our industry leading one-year, two-year, three-year and lifetime warranties which you can identify throughout the catalog using the symbols shown at the left.

www.manualsplus.com
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